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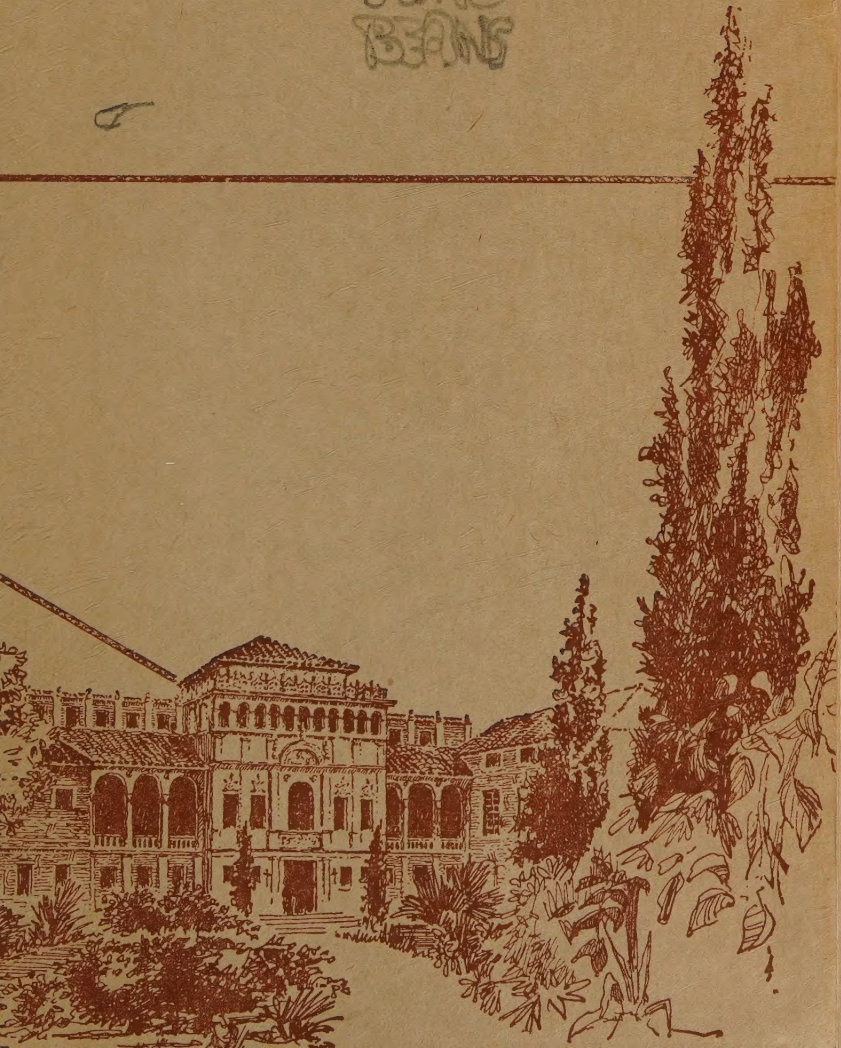

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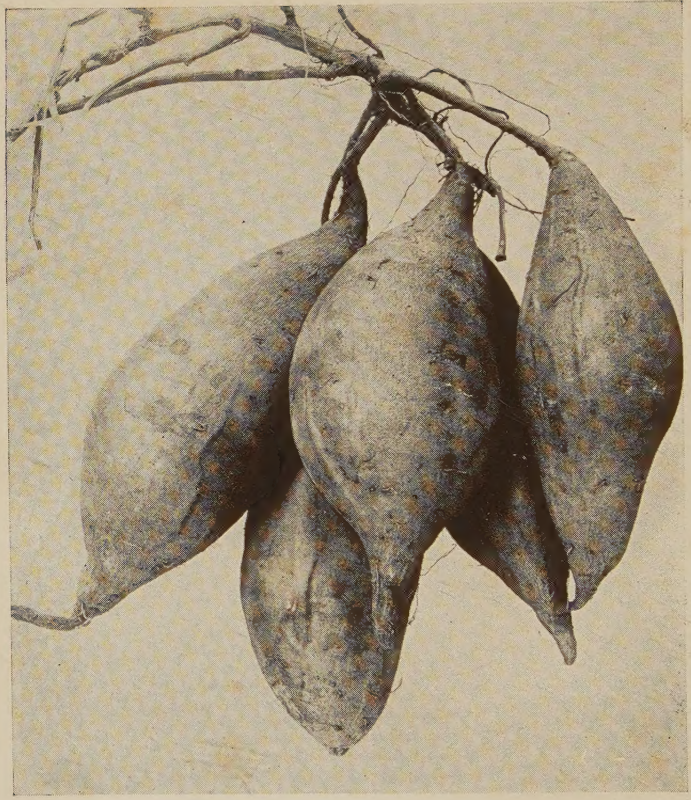

A Good Hill of Yellow Jersey Sweet Potato

Courtesy Bureau of Plant Industry, U. S. Department of Agriculture

Sweet Potato Production and Handling

By H. C. Thompson

Professor of Vegetable Gardening, Cornell University, Formerly Horticulturist, United States Department of Agriculture

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AUTHOR'S PREFACE

In the preparation of this book the author has attempted to give in concise and understandable form the essential facts and principles concerned in the successful production and handling of sweet potatoes. The results of research and experiments have been studied and, while relatively few data have been given, the results have been interpreted and recommendations made in accordance with the findings. On many subjects discussed no experimental or research evidence was found and, in such cases, the author has given what he believes to be the best empirical information available.

Extensive use has been made of the publications issued by the agricultural experiment stations of several states and by the United States Department of Agriculture. Credit has been given for the material used. The reader is advised to study the publications giving results of experimentation and research on the particular subjects of his interest. He should consult also his County Agricultural Agent and the specialists of the Agricultural College in his own State when he has special problems needing specific attention.

The numbers given in small figures in the text refer to literature on pages 119-125.

H. C. Thompson

Ithaca, N. Y.

EDITOR'S PREFACE

We were fortunate in securing the services of Professor H. C. Thompson, head of the Department of Vegetable Gardening of Cornell University, to prepare the manuscript on "Sweet Potato Production" for the Vegetable Garden Series.

Professor Thompson was a specialist in the employ of the United States Department of Agriculture for twelve years, and during a considerable part of this period he gave major attention to sweet potato problems. For seven years he was in charge of production and storage investigations, when he made a thorough study of the industry in all the important commercial districts of the country. He also designed the so-called government type of sweet potato storage house which is so popular in the South, and during the World War he had charge of the campaign to encourage the building of sweet potato storage houses as a food conservation measure.

By training and experience Professor Thompson is eminently qualified to discuss the growing, storing, and marketing of sweet potatoes. We believe that this little volume will be exceedingly helpful to all who are desirous of increasing their knowledge of a crop which ranks second among the vegetables in commercial importance, the Irish potato occupying first place.

R. L. Watts

State College, Pennsylvania

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Please do not write in this
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SWEET POTATO PRODUCTION AND HANDLING

I

THE SWEET POTATO AS A CROP PLANT

Origin and History

The sweet potato is probably of tropical American origin, and was carried to the islands of the Pacific very early. It is thought to have been known in China early in the Christian Era, and probably was cultivated by the American Indians hundreds, perhaps thousands, of years before the discovery of America by Columbus. Many varieties had developed in South and Central America by the latter part of the fifteenth century. Early in the sixteenth century the sweet potato had been carried to Spain, and to several other parts of Europe by the latter part of that century. It was mentioned as one of the cultivated crops of Virginia in 1648.*

Taxonomy

The sweet potato (*Ipomoea batatas* Lam.) is a member of the *Convolvulaceæ,* or Morning Glory, family. The genus Ipomoea contains 400 or more species widely distributed over the world, but chiefly in tropical countries. The sweet po-

* For a more extended discussion see Sturtevant's Notes on Edible Plants.[7]

tato is a tuberous-rooted perennial, although it is grown as an annual crop in the United States.

While the sweet potato plant seldom produces flowers in the northern part of the sweet potato growing region of the United States, a few are produced in some seasons although these never set seed. In most sections of the Lower South some flowering occurs every year and in some years, flowers are produced in fair abundance, but even here seed seldom is produced. Even in tropical countries, where flowering is common, seed often fails to set. A relatively dry tropical climate is conducive to seed production.

The flowers of the sweet potato are funnelform, three-fourths of an inch to 1½ inches in diameter at the top and 1 inch to 1½ inches long. The color varies considerably, being usually rose-violet or bluish with a darker color in the throat. The flowers are perfect, having 5 stamens of varying length surrounding the pistil and attached to the corolla tube, near its base. Two of the longer stamens meet at, or extend beyond, the stigma, facilitating self-pollination. The seeds are black, flattened, more or less disk-shaped, and angular in form, measuring about 3.3 millimeters in greatest diameter. They are borne in capsules similar to those of the morning glory and range from 1 to 4 in a pod.

Climatic Requirements

The sweet potato plant thrives best in a long, warm growing season and is tender to frost. It is not grown successfully in regions having less

than four months frost-free period with warm or hot weather for a large portion of that time. The nights as well as the days must be relatively warm. On Long Island, where the growing season is long, the sweet potato does not produce a satisfactory crop because during the early part and the latter part of the growing season the days are relatively cool and the nights are cool most of the time. On the other hand, some varieties of sweet potatoes produce good yields in certain sections of Iowa, especially in the vicinity of Muscatine, where the frost-free period is considerably shorter than on Long Island. In the Muscatine area the weather becomes warm quickly and is hot during a portion of the summer.

The sweet potato grows better than most other vegetables in a comparatively dry climate. Fairly large yields have been produced without irrigation in semi-arid regions where most vegetables do not thrive unless irrigated. A moderate rainfall during the growing season is, however, desirable.

Important Regions of Production

The sweet potato is an important food crop in practically all tropical and sub-tropical countries, as in portions of Africa, in India, Japan, China, the Malayan Archipelago, the Pacific Islands, tropical America, and in the southern part of the United States. In the United States the important regions of production include all of the southern states, and portions of New Jersey, Delaware, Maryland, Illinois, Missouri, and Cali-

fornia. Other states producing 2,000 acres or over in 1925 were Kansas, Iowa, Ohio, Indiana, Pennsylvania, West Virginia, and Arizona, making a total of 26 states growing sweet potatoes on a commercial scale.

Commercial Importance

The sweet potato ranks second in commerical value among the vegetables, preceded only by the Irish potato. In most of the southern states it is of greater importance than the Irish potato. As with most other vegetables, the acreage, production, and farm value of the sweet potato crop fluctuate considerably from year to year (Table 1). When the price paid for sweet potatoes during a certain year is low, as compared to competing crops, the acreage is likely to be reduced the next year, and vice versa. The fluctuations in total production from year to year mainly are due to difference in weather conditions, especially rainfall, and to changes in acreage planted. The wide range in price is due to the relationship between supply and demand, but the supply of Irish potatoes has considerable effect on the demand and on the price paid for sweet potatoes.

Food Value

The sweet potato is rich in carbohydrates and has a higher energy value than most other vegetables. According to Langworthy [68] the sweet potato contains about 9 per cent less water and 9 per cent more carbohydrates than the Irish potato. Of still greater importance is the nature of

TABLE 1.—THE SWEET POTATO CROP IN THE UNITED STATES

Acreage, Production, and Farm Value, 1914-1925 (Yearbook 1925)

YEAR	*Acreage*	*Production*	*Price per Bushel, cents*	*Total value (dollars)*
1914.....	603,000	56,574,000	73.0	41,294,000
1915.....	731,000	75,639,000	62.1	46,980,000
1916.....	774,000	70,955,000	84.8	60,141,000
1917.....	919,000	83,822,000	110.8	92,916,000
1918.....	940,000	87,924,000	135.2	118,863,000
1919.....	941,000	97,126,000	134.4	130,514,000
1920.....	992,000	103,925,000	113.4	117,834,000
1921.....	1,066,000	98,654,000	88.1	86,894,000
1922.....	1,117,000	109,394,000	77.1	84,295,000
1923.....	993,000	97,177,000	97.9	95,091,000
1924.....	691,000	54,564,000	129.2	70,500,000
1925.....	778,000	62,494,000	136.9	85,554,000

TABLE I.—*Continued*

FIFTEEN LEADING STATES IN 1925

STATE	*Acres*	*Production* (*bushels*)	*Farm value* (*dollars*)
Georgia	110,000	5,170,000	6,462,000
Texas	84,000	6,132,000	8,707,000
North Carolina	80,000	7,040,000	8,448,000
Louisiana	72,000	5,760,000	6,624,000
Alabama	65,000	4,550,000	5,688,000
Mississippi	62,000	5,952,000	5,952,000
South Carolina	52,000	2,860,000	4,204,000
Virginia	37,000	3,996,000	5,195,000
Tennessee	36,000	3,240,000	4,536,000
Florida	29,000	2,465,000	3,451,000
Oklahoma	20,000	1,880,000	2,538,000
New Jersey	18,000	2,106,000	5,054,000
Kentucky	14,000	1,260,000	1,928,000
Delaware	11,000	1,210,000	2,299,000
Maryland	10,000	1,290,000	2,193,000

PLATE I.—EFFECTS OF POTASH ON SIZE AND SHAPE OF SWEET POTATOES

Upper—Grown Without Potash. *Lower*—Grown with 8 per cent Potash. Courtesy of New Jersey Agricultural Experiment Station

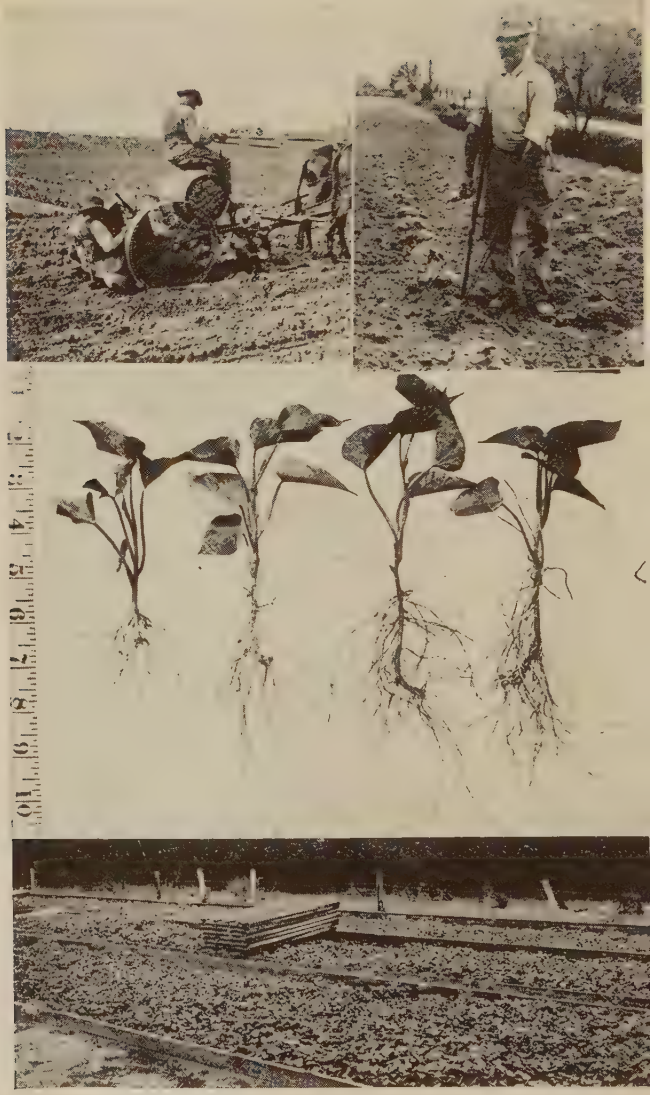

PLATE II.—*Upper left*—A Machine Planter Used for Setting Sweet Potato Plants. *Right*—Tongs and "Spud" Used for Setting Plants by Hand. *Center*—Good Plants for Setting. *Lower*—Sweet Potato Plants Beds. Courtesy Bureau of Plant Industry, U. S. Department of Agriculture

the carbohydrate, the sweet potato containing a considerably larger percentage of sugar than the Irish potato. The average composition of sweet potatoes and Irish potatoes is given in table 2, on page 16.

The sweet potato also supplies vitamins, being rich in vitamins A and C and fairly rich in B. An adequate supply of these three vitamins not only serves to prevent disease but also to promote normal growth and bodily function, and to maintain general good health.

Uses

The sweet potato is used largely as human food, although it is also valuable as feed for animals. As human food sweet potatoes occupy the same place in the diet as Irish potatoes and furnish a good, palatable substitute for them. Sweet potatoes are prepared for the table in a great variety of ways, the most common being baking or boiling. They are also parboiled and roasted with meat, sliced and fried, cooked with sugar and butter (when they are commonly called "candied"), and used in making pies. The sweet potato is canned in considerable quantity. In 1925 the total pack of canned sweet potatoes was the equivalent of 762,195 cases of number 2½ cans.

TABLE 2.—AVERAGE COMPOSITION OF SWEET POTATOES AND IRISH POTATOES

KIND	*Refuse*	*Water*	*Protein*	*Fat*	*Carbohydrates*		*Ash*	*Fuel value per pound*
					Sugar, starch etc.	*Crude fiber*		
Sweet potato	%	%	%	%	%	%	%	*calories*
(Edible portion)	...	69.0	1.8	0.7	26.1	1.3	1.1	560
Sweet potato (as purchased)	20.0	55.2	1.4	0.6	21.9		0.9	450
Sweet potato (cooked)	...	51.9	3.0	2.1	42.1		0.9	905
Sweet potato (canned)	...	55.2	1.9	0.4	40.6	0.8	1.1	800
Irish potato (Edible portion)	...	78.3	2.2	0.1	18.0	0.4	1.0	375
Irish potato (as purchased)	20.0	62.6	1.8	0.1	14.7		0.8	305

II

PLANT GROWING

SWEET POTATOES are grown from plants or "slips" produced from seed roots, or from cuttings of the vines. In the northern sweet potato-growing sections most of the commercial crop is grown from slips since the growing season is too short for the production of marketable-size potatoes from vine cuttings. In some sections of the North, vine cuttings are used for growing sweet potato seed, since the cuttings are less likely to carry disease than are the slips.

South of Virginia a considerable portion of the main crop is grown from vine cuttings. In this case enough roots are bedded to produce sufficient plants for from one-sixth to one-eighth of the area to be planted. The slips are planted in the usual manner and, when the vines have made considerable growth, cuttings are taken to plant the remainder of the field. The planting of vine cuttings usually extends over a considerable period.

SEED SELECTION

A large part of the seed stock is obtained either in the field at harvest time or from the storage house or bank without giving any attention to selection. Small or medium-sized roots are

used commonly for seed purposes since these produce more plants per bushel than do the larger ones. Experiments carried on by several of the southern experiment stations have shown no consistent results favoring the use of large seed. This might be expected, since small potatoes are as likely to be produced with large ones by high-yielding hills as from low-yielding hills. Selection, however, should be made in the field at harvest time and the grower should consider the vigor of the plant, the yield, the shape and size of the tuber, and disease resistance. The methods of selection are discussed under "Improvement" in Chapter V.

The stock selected for seed purposes should be handled carefully and stored in separate containers from the general crop. It is not advisable to sort the roots to remove decayed ones until time for bedding in the spring, since handling results in some bruising which increases the loss due to rots in storage. Some growers have the impression that seed sweet potatoes stored in dry storage houses are slower to sprout and produce fewer plants than potatoes kept in outdoor banks. Preliminary experiments conducted by Hoffman [65] at Cornell University indicate that there is no basis for this belief. In fact, the advantage appears to be in favor of the cured potatoes.

Plant Beds

Sweet potato plants are grown nearly always in some sort of a plant bed. This may be an excavation in the open, a cold-frame, or a hotbed.

The hotbed may be heated by fermenting manure, by hot air carried through flues running beneath the bed, or by hot water or steam. The kind of bed used depends upon the region and the time the crop is desired. In most northern sections where sweet potatoes are grown some form of artificial heat is used. For a very early crop in the South artificial heat, usually supplied by fermenting horse manure, is used also.

Open Plant Beds—In most sections of the South plants for the main crop are grown in open beds. An excavation is made 5 or 6 inches deep, 5 to 6 feet wide and as long as is desired or as may be necessary to accommodate the quantity of seed to be bedded. A layer of sand or loose soil 3 or 4 inches deep is spread on the bottom of the excavation and levelled off preparatory to bedding the seed. Some growers make a practice of covering the beds with several inches of straw, hay or other litter after the potatoes are bedded. This material prevents rapid drying of the soil and protects against cold. When such a method is followed it is desirable to remove the covering during a portion of the day early in the season so as to allow the soil to become warm. The covering is put back before night to hold in the heat. After the plants break through the surface of the soil, the covering should be kept off unless there is danger of frost, when it should be put on, but removed again as soon as the danger is past.

Cold-frames—Cold-frames are used for the production of sweet potato plants for the main crop in some of the cooler regions of the South,

and for an early market crop in the lower sections. These frames are covered either with standard hotbed sash or with canvas or other cloth cover. The cold-frame may be built entirely above ground or partially below ground. A common method is to make an excavation 5 or 6 inches deep, and 6 feet wide. A frame is made of boards 1 inch thick, 12 inches wide for the back and 6 or 8 inches wide for the front of the bed. The end boards are cut to fit between the sides. The sides and ends are held in place by driving 2 by 4 or 2 by 2 inch stakes into the ground at intervals of 6 feet, and nailing the frame boards to them. Strips of board 1 by 2 or 1 by 4 inches often are nailed across the bed. When hotbed sash is used for covering, these strips are placed 3 feet apart on center and serve as supports and slides for the sash. When canvas or other cloth covering is used the strips may be farther apart, or replaced by heavy wire fastened to the sides of the bed. When the bed is below the surface the frame is made to fit the excavation, or the space between the frame and sides of the excavation is filled with soil and banked a little above the surface on the outside to insure drainage away from the bed and to keep out cold. When built above ground the frame is nailed together and set on the surface, and soil is banked up around it to protect against cold and water. For a more permanent cold-frame the walls are made of concrete instead of wood.

Hotbeds—Hotbeds of some kind are used almost universally in the northern part of the sweet

potato-growing region because the season is too short for the production of a good marketable crop unless the plants are started while the weather is cold.

Manure-heated hotbeds are the most common, especially where the crop is grown on a small scale. Other means of heating are not practicable for small-scale plant growing unless the heating plant can be used for other purposes. The most common method of making a manure-heated hotbed is to make an excavation 12 to 18 inches deep, about 6 feet wide, and as long as may be desired. A frame is made as described for the cold-frame, and this is held in place by nailing it to stakes driven into the ground at intervals of 3 to 6 feet. Fresh horse manure, containing considerable straw, is used for supplying the heat. It is desirable to pile the manure several days before placing it in the pit and to turn it once or twice in order to have it well mixed and uniform throughout the pile. A week or ten days before bedding, the manure is placed in the pit in layers and is well packed by trampling. This should be 10 to 12 inches deep after being packed. The hotbed may be made entirely above ground. In this case the manure is packed in a flat pile 2 to 3 feet deep on the surface of the soil. The pile should be 3 or 4 feet wider and longer than the frame. The frame is set on the pile and manure is banked against the outside to protect from cold. A layer of sand or soil 3 or 4 inches thick is placed on the manure and the bed is covered with sash and left for a least a week, or until the temperature

has become uniform and has dropped to 80° or 85° F.

Flue-heated hotbeds are used commonly in some sections for growing sweet potato plants in large quantities, especially where it is difficult to obtain good manure. The heat is supplied by means of a stove or furnace connected with flues running beneath the bed. Such a hotbed is made 6 or 12 feet wide and up to 60 or 75 feet long. The side walls are made of wood, brick, stone, or concrete, wood being the most common, although the other materials make a more durable structure which is cheaper in the long run. A type of open bed used in New Jersey is described by Nissley.[12] He recommends locating the fire-box at the north end of the bed. The fire-box must be deep enough to insure good circulation of air. The depth should be sufficient to allow 18 inches of soil between the top of the fire-box and the space under the bed. A fire-box 3 feet wide, 6 feet deep, and 4 feet high is suggested and this should be lined with clay fire-brick. "The entrance to the fire-box should extend down 6 to 8 inches from the top, thus forming a pocket in the top of the box. If this is not done, there may be a back draft and the smoke may come out of the fire-box instead of going into the flues."

For a bed 60 feet long and 12 feet wide two 6-inch flues are necessary. These leave the fire-box at the rear as close to the top as possible. Round vitried tile pipe 6 inches in diameter is satisfactory. The flues are placed under the ground to within 4 or 5 feet of the end of the

bed, where they come to the surface of the soil underneath. For a 30-foot bed one 8-inch flue is sufficient. The floor over the flue end should be protected with asbestos or sheet metal since the air issuing from this short flue is hot and may start a fire unless the floor-boards are protected.

In the type of bed described, two chimneys are constructed, one in each corner at the fire-box end of the bed. The air and smoke, after passing out of the flues near the far end of the bed, make their way back and go out the chimneys. The height of the chimney is determined by the location of the bed, and ranges from 3 or 4 to 6 or 8 feet high. With the open bed described, a covering of 12 to 16 inches of marsh hay is placed over the soil after the sweet potatoes are bedded and covered. The same kind of bed can be covered with hotbed sash and used for growing other plants.

Where a steam or hot-water boiler is used for heating other structures it often can be employed to advantage for heating the sweet potato bed. In fact, if plants are grown on a very large scale, it may be advisable to install a boiler for heating the plant bed even if it is not used for any other purpose. The temperature of the bed can be regulated more readily where steam or hot water is used than where any other method of supplying heat is employed. Hot-water or steam pipes give best results when placed near the bottom of the hotbed pit several inches below the soil on which the potatoes are bedded. A floor of tiles or boards is made above the heating pipes

and held in place on pipe or wood supports. The number and size of pipes needed depend on the rapidity of circulation and on the temperature of the water or the pressure of the steam. When hot water is used four 1½-inch pipes are ample for a bed 6 feet wide and not over 50 feet long. For longer beds 2-inch pipes are better. Two of the pipes serve as flow pipes and two as returns. The water enters one end, makes the circuit, and leaves the bed at the same end. The point where the pipes enter the bed must be the highest point in the system and there must be a drop from the far end of the bed to the boiler. The pipes should have an even grade and be spaced evenly with the flow pipes about a foot from each outside wall and the returns in the center. When steam is used the arrangement of the pipes is the same, but smaller pipes are used. With 10 pounds pressure, 1-inch pipe is large enough for beds 50 feet long and 1¼-inch for beds up to 100 feet.

Locating the Plant Bed

Regardless of the kind of bed used for growing the plants, it is desirable to have it on the protected side of a building, a fence, or a windbreak. A south, or a southeast slope generally is preferred and the protection should be on the north, or on the west side. For convenience in caring for the bed it is important to locate it near the house and near a water supply. A location along a frequently traveled walk will be found advantageous, since this will obviate the necessity of special

trips and at the same time afford opportunity for inspection and care of the bed.

Soil for the Plant Bed

Clean sand, free from sweet potato diseases, is the best kind of soil for the plant bed. Loose, loamy soil is used often and this is satisfactory if it has been obtained from a location where sweet potatoes have not been grown, and contains no washing or refuse from a sweet potato field. New soil should be used each year or the old soil sterilized. Sterilizing is much cheaper than changing the soil. The simplest and probably the cheapest method of sterilizing is by soaking the soil with formaldehyde solution made by mixing 4 pints of commercial formalin with 50 gallons of water and applying it at the rate of one gallon to each square foot of bed surface. C. H. Nissley compared the cost of sterilizing with the cost of changing the soil. In 1925 he selected two 10 by 60 foot concrete beds for the comparison. These beds were located side by side on the same farm near Vineland, New Jersey. One bed was sterilized with formaldehyde solution applied through a hose from a 200-gallon orchard sprayer, using three full tanks or 600 gallons of solution to 600 square feet of bed. It took three hours to make the application which required 48 pounds of formalin at 12 cents per pound.

The soil from the second bed was removed to the depth of 6 inches and replaced with new soil from a nearby woods. Nissley states (in a personal letter) that there was no disease in

either bed, but that the plants in the sterilized bed came through earlier and were, therefore, available for field setting before those in the new soil. This he thought was due to the fact that there was more moisture in the sterilized bed than in the other one.

When formaldehyde is used it should be applied at least eight days before bedding the potatoes. After applying the solution the soil surface is covered with old burlap, old carpets, building paper or other material to confine the gas for 48 hours. After this interval the covering is removed and the bed is heated. Thorough aeration of the soil is essential.

A layer of sand or soil 3 or 4 inches deep is spread over the surface of the open bed or cold-frame, on the floor or on the manure of the hot-bed. A deeper layer is desirable where hot air, steam, or hot water is used. DeBaun [2] suggests 10 inches of soil for steam or hot water-heated beds and 3 to 6 inches for flue-heated beds. Where boards or planks are used for the bottom of the bed, it is often necessary to put on a layer of manure or other material to prevent the soil from sifting through the cracks.

Disinfecting the Seed Roots

Just before the potatoes are to be bedded the seed stock should be sorted carefully and all roots showing any disease discarded. Roots with badly shriveled ends also should be discarded as these may be infected with stem rot. Since the spores of various diseases may be sticking to

the surface of the potatoes, it is important to disinfect them before bedding. This is done by treating from 5 to 10 minutes in a solution made by dissolving one ounce of corrosive sublimate (mecuric chloride) in 8 to 10 gallons of water. Only wooden vessels should be used and, since corrosive sublimate is a strong poison, great care should be taken to keep the solution out of the reach of animals. The solution should not be used more than three times as it becomes weak after repeated use. After treating the potatoes with corrosive sublimate solution, they should be rinsed in clean water and spread out to dry before bedding. Where a large quantity of sweet potatoes are to be disinfected, barrels, or large wooden tanks will be found very satisfactory. If the potatoes have been stored in crates, these may be placed in the solution and left there for the desired time, and then dipped into a vessel of clean water. Burlap bags are satisfactory if crates are not available.

Bedding the Seed

The time of bedding varies in different regions. In the northern sections the potatoes are bedded about a month or 6 weeks before the danger of frost is over as it is necessary to have plants to set early in order to produce a satisfactory crop before frost kills the vines in the fall. In the South sweet potatoes for the early market are bedded early enough to have plants ready to set as soon as the danger of frost is over. For the

general crop in the South bedding usually takes place later and little or no protection is given.

The quantity of seed to bed to get enough plants to set an acre of land depends upon the size of seed roots, the distance apart the plants are to be set, and the number of pullings that can be made. As already mentioned small potatoes produce more plants per bushel of seed than large ones. In New Jersey growers usually save about 4 bushels of seed for each acre to be planted, but 3 bushels at bedding time are sufficient. If only one pulling is made, 6 to 8 bushels are required, but in most regions two or three pullings can be made. Where vine cuttings are used for the main planting enough seed is bedded to produce plants for about one-sixth or one-eighth of the area to be planted.

In bedding, the potatoes are placed on the smooth surface of the bed as close together as practicable, without allowing them to touch, and then are pressed into the sand or soil. One bushel of small roots requires about 24 square feet of bed area when bedded in this manner and will produce 1,500 to 2,000 plants in three pullings. Some growers count on only 1,000 plants from each bushel of seed, but they usually get many more than this. After the potatoes are pressed into the soil they are covered with about an inch of sand or soil. The soil is then watered thoroughly, and the beds are covered, if covering is to be used. When the sprouts begin to appear more soil is added so that the potatoes are covered finally to the depth of 2 or 3 inches. This in-

sures a good root system for 2 or 3 inches along the stem of the plant. Some growers follow the practice of placing chicken wire over the potatoes as soon as they are pressed into the soil and before they are covered. This wire holds the potatoes in place when the plants are pulled for setting.

Where manure is used for supplying heat in a hotbed the potatoes should not be bedded for several days after the manure is placed in the pit and the temperature has dropped to 80° or 85° F.

Care of the Plant Bed

For best results the soil of the plant bed should have a temperature of 80° or 85° F. at bedding time, and this should fall gradually to about 70° or 75° F. in 4 to 6 weeks or before planting time. A thermometer should be thrust into the soil of the bed and the temperature noted every day for the first ten days. The air temperature should be maintained between 60° and 80° F. During bright days ventilation is necessary to regulate the temperature. In the case of manure-heated beds a little ventilation is desirable every day during the first week or two to allow the escape of gases from the fermenting manure.

The plant bed should be watered only when the soil becomes dry. Frequent sprinkling should be avoided since this keeps the surface moist and makes soft growth and favors the development of disease. Soak the soil thoroughly at each watering and then withhold water until there is evident

need of it. The larger the plants the more water will be required, hence it is important to give the beds frequent attention.

In ventilating the beds during cool weather it is best to pull down the sash a short distance from the top, or to raise them on the side opposite the direction of the wind. Before time for field planting the sash should be kept off during the day and also at night unless there is danger of chilling the plants.

A good plant is ten to twelve inches high and stocky, with a good set of roots for 2 or 3 inches along the stem. A soft succulent plant is likely to suffer when planted, hence some hardening is desirable. This may be accomplished either by withholding water for a few days before planting or by exposing them to cool temperature.

Slips vs. Vine Cuttings

In regions having a short growing season the yield of sweet potatoes is usually larger from slips than from vine cuttings because vine cuttings are not available as early as slips. As cuttings are taken from vines produced from slips, the cuttings cannot be planted until the plants have grown for three, four, or more weeks. If slips were planted at the same time as the cuttings the yield would probably be as large, if not larger, than from the cuttings. Experiments carried on in Georgia [18] for one year indicate that when late planting is made vine cuttings produce a much larger yield than slips. Results of experiments carried on in Arkansas [11] for two years show very

little difference in yield between slips and vine cuttings. The average yield was 134.75 bushels per acre from slips and 139.25 bushels from vine cuttings, and the percentage of marketable potatoes was slightly higher from the latter. The small difference in yield in this experiment is not significant.

The experience of farmers and the results of experimentation both tend to show that vine cuttings are better than slips for growing the main crop in most sections of the South. As a rule the potatoes are smoother and more uniform in size and shape when grown from vine cuttings than when grown from slips. This is due probably, in part, to the fact that vine cuttings are planted later than slips. Vine cuttings are cheaper and less likely to carry disease than slips. Cuttings are especially desirable for the growing of seed sweet potatoes and the method is used to some extent for this purpose even in regions where the growing season is too short to produce a good marketable crop from vine cuttings.

III

SOILS AND SOIL MANAGEMENT

Kind of Soil

Sandy and sandy-loam soils with a clay subsoil are generally considered best for sweet potatoes, although the crop can be grown with success on a wide range of soils if other conditions are favorable. The crop is grown sometimes on pure sand and, when heavily fertilized, produces fairly large yields. Very heavy soils are not satisfactory for growing the crop for market as the potatoes are likely to be rough and irregular in shape. On very rich soils the crop tends to run to vines and the potatoes formed are likely to be rough, irregular in shape, and to grow too large. Fairly large crops can be grown on the so-called worn-out cotton and tobacco lands of the South, provided a good rotation is followed and liberal fertilization is given. Newly cleared land, such as the cut-over pine lands of the South, is especially well adapted to sweet potato growing. It is better, however, to grow corn the first year, since the roots of trees and bushes in newly-cleared soil interfere with the cultivating and harvesting of the crop.

Good drainage is very important for sweet potatoes and, unless the land is naturally well drained, it should be artificially drained. Open

PLATE III.—THREE STANDARD VARIETIES OF SWEET POTATOES.
Left—Porto Rico. *Center*—Big Stem Jersey. *Right*—Nancy Hall.

PLATE IV.—BUD SPORT OF SWEET POTATO OF HAITI VARIETY

Upper—Plant With 3 Yellow and 3 Red Roots. *Lower*—Yellow and Red Progenies From the Same Plant. Courtesy of Bureau of Plant Industry, U. S. Department of Agriculture

ditches are commonly used on the level lands in the South, and, in addition, the plants are set on ridges. Tile drainage is employed in some sections, and is preferable to open ditches because of the waste of land taken up by the ditches.

A sandy loam surface soil from 6 to 8 inches deep, underlaid with a clay subsoil which is porous enough to carry off the surplus water, is considered almost ideal.

Preparation of the Soil

As a rule no special preparation is given soil for sweet potatoes and in many cases the land is prepared poorly. Plowing may be done in the fall, in the winter, or in the spring, depending on the nature of the land and the cropping system followed. It is considered advisable to plow sod land during the fall or winter and leave it rough until spring. If a winter cover crop or a green-manure crop is grown on the land, spring plowing is to be recommended in order to allow as much time as practicable for the growth of the crop to be turned under. Plowing should be done far enough in advance of planting to allow the soil to settle. If a heavy cover crop or green-manure crop is growing on the land it should be plowed 3 or 4 weeks before time for planting. The depth of plowing has considerable influence on the shape and length of the potatoes, hence, the plowing should not be too deep nor too shallow. The depth usually plowed for corn is satisfactory. Where shallow plowing is practiced the deficiency in depth is made up by ridging which allows a

greater depth of soil for the development of the potatoes than would be the case if level culture were practiced. A shallow soil should be deepened by plowing a little deeper each year until the desired depth is reached. Turning up 2 or 3 inches of raw subsoil at one time is not to be recommended.

After the soil has been plowed it should be put in good condition by whatever means is necessary. Only light harrowing is necessary on some soils, while others require disking and dragging or rolling as well as harrowing. Good preparation is desirable and will save labor later in cultivation. The time to prepare the soil is before the crop is planted, for cultivation cannot take the place of preparation.

When ridge culture is followed the ridges usually are thrown up with a plow, throwing two furrows together. Where the drainage is poor, ridge culture is probably important, but the ridges should be as low and flat as the conditions will permit. Narrow, sharp ridges dry out more readily than low, flat ones. Where the drainage is good, level culture is probably better than ridge culture, especially where droughts are prevalent. In a wet season ridging is likely to pay, while in a dry season level culture will be found preferable. Starnes [17] at the Georgia Experiment Station compared level culture with ridges 14 inches high and found that in one year the yield was higher with ridge culture while the next year the opposite was true. The yields the first year were 272.75 bushels per acre for ridge cul-

ture and 237 bushels for level culture, while the next year the yields were 237.2 and 270.3 bushels per acre, respectively. Since the experiments were for 2 years only, and since the differences were slight and reversed, too much dependence should not be put on them.

In general, it would seem wise to use ridges when there is any doubt regarding the drainage, since it is impossible to predict in advance whether the season is going to be dry or wet.

Crop Rotation

Rotation of crops is important in soil improvement and in the control of diseases and insects. Several diseases of sweet potatoes live over in the soil and increase in severity from year to year unless crop rotation is followed. By following a rotation which includes crops having different feeding habits and including green-manure and cover crops, the soil can be improved. While rotations must be planned by the individual grower to meet his own local conditions and cropping systems, the following recommended by Miller [10] are offered as suggestions of desirable types.

"For the cotton belt, where sweet potatoes are grown as a farm crop:

(1) First year.—(a) Cotton, followed by rye for winter pasture or as a crop to turn under; or, (b) Corn, with cowpeas or velvet beans planted as a soil-improving crop.

Second year. Sweet potatoes, followed by a winter cover crop of rye, or oats and vetch.
Third year. Oats, followed by peanuts or cowpeas.

(2) First year. Sweet potatoes, followed by a winter crop of rye, or oats and vetch.
Second year. Cotton with rye sown between the rows for winter pasture, or to turn under.
Third year. Corn, with cowpeas or velvet beans planted as a soil-improving crop.

A 4-year rotation for the southern sweet potato section:
First year. Sweet potatoes.
Second year. Winter oats, followed by peanuts or cowpeas.
Third year. Cotton, with bur clover between the rows.
Fourth year. Corn, with cowpeas or velvet beans between the rows.

A 3-year rotation for the Eastern Shore of Virginia and Maryland:
First year. Sweet potatoes, followed by crimson clover or rye as a winter cover crop.
Second year. Early Irish potatoes. On many farms corn is planted between the rows of potatoes at the last cultivation; on other farms the potatoes are followed by fall vegetables.
Third year. Winter oats, followed by cowpeas for hay."

In some sections of the South sweet potatoes follow a crop of Irish potatoes or other vegetable grown for an early market. In this case no fer-

tilizer is applied to the sweet potato crop since the soil usually is fertilized heavily for the other crop.

Fertilizers and Manures

Satisfactory yields of sweet potatoes are produced by the use of commercial fertilizers alone, providing other conditions are favorable. Since the sweet potato gives better results than most other crops on humus-deficient soils, manure can be used to better advantage on other crops. This does not mean that manure should never be used in growing sweet potatoes, although experimental results obtained at several experiment stations show that larger net returns might be expected from commercial fertilizers than from manure, provided the charge for the manure is near its cost when purchased, or its value when used on other crops. Fresh manure, applied in considerable quantities, causes a rank growth of vines and the development of large, rough roots. It seems best, all things considered, to use commercial fertilizer for sweet potatoes and the manure for other crops in the rotation.

Many experiment stations have conducted manure and fertilizer experiments, but the results are so conflicting that no specific recommendations can be made from them. In most cases, the experiments were not carried on long enough to justify definite conclusions. In other cases there were not enough replications to make it clear whether the differences were due to the treatments or to variations in the soil. However,

it is suggested that the grower consult the publications and obtain advice from the agricultural experiment station in his State.

Nitrogen—Nitrogen in some form is necessary for growth of all crops, but the sweet potato does not draw heavily on this element. On fairly rich soils, or where manure is used in the rotation, little or no nitrogen need be applied. On most land used for growing sweet potatoes in the South, and on the sandy trucking soils of the North, some nitrogenous fertilizer should be applied unless a surplus has been left from previous crops.

Experiments by Vorhees and later by Schermerhorn [15] in New Jersey gave results which indicate that organic sources of nitrogen, as tankage, dried blood, etc., are slightly better than inorganic forms, as nitrate of soda and sulfate of ammonia, leaving cost out of consideration. Since nitrate of soda and sulfate of ammonia are cheaper per pound of nitrogen than the organic carriers of this element, the organic carriers might not be economical. A mixture of organic and inorganic carriers of nitrogen would probably be preferable to either alone. The organic material serves as a drier and improves the mechanical condition of the fertilizer mixture, while the nitrogen in nitrate of soda and sulfate of ammonia is more readily available than that in tankage, fish scrap, or cottonseed meal.

Results of studies reported by Schermerhorn [15] indicate that the quantity of nitrogen influences the shape of the potatoes. In excessive quantities nitrogen tends to produce long potatoes. In gen-

eral, as the percentage of nitrogen (in a complete mixture) increased, the length of the potatoes increased and the diameter decreased. The quantity of this element that should be applied depends, of course, upon the quantity in the soil.

Phosphorus—Phosphorus, like nitrogen, is essential to growth. The sweet potato apparently does not draw heavily on this element. Vorhees [19] states that 200 bushels of sweet potatoes, not including the vines, contain, on the average, 30 pounds of nitrogen, 10 pounds of phosphoric acid, and 55 pounds of potash. Keitt [67] also showed that the sweet potato removed more potash than nitrogen and more nitrogen than phosphorus. Since, however, most soils are deficient in phosphoric acid and many farm crops draw heavily on it, and in view of the fact that it is returned in smaller quantity in manure than is either nitrogen or potash, most mixtures contain from 6 to 8 or even 10 per cent. This may be a safe practice, as the phosphoric acid is not readily leached out if it is not used by the crop for which it is applied and will be available for succeeding crops.

Potash—This element also is essential to growth of all plants and the sweet potato apparently uses it in large quantities. However, many soils contain a sufficient quantity of it, so that applications are unnecessary. Considering all of the experiments, it would seem wise to apply some potash to sandy or sandy loam soils in most sections unless manure is used in the rotation. Schermerhorn suggests a 3-8-8 mixture at the rate of

1,000 to 1,500 pounds to the acre for sandy and sandy loam soils in New Jersey.

Potash apparently has a rather marked effect on the form of the sweet potato. Schermerhorn [15] has shown that as the percentage of potash in the mixture increased the length decreased and the diameter increased. Where a short, chunky potato is desired, as on many northern markets, a good application of potash, perhaps the equivalent of 100 or 150 pounds of muriate, should be made.

Results of several studies show rather conclusively that muriate is preferable to sulfate of potash and, since the former is cheaper, it is generally recommended.

Fertilizer Practice—Where the sweet potato is grown as a general farm crop in the South, either no fertilizer is used or only a small quantity, 200 to 400 pounds of a low-grade mixture, is applied. Under most conditions a fairly liberal application would be profitable. A mixture of equal parts of cottonseed meal and 16 per cent acid phosphate, or one part of the former to 2 or 3 parts of the latter, often is used at the rate of 500 to 600 pounds to the acre. Equal parts of cottonseed meal and 16 per cent acid phosphate would supply about twice as much phosphoric acid as nitrogen, and a very small quantity of potash. Where the sweet potato is grown as a truck crop on light sandy or sandy loam soils, from 1,000 to 1,500 or even 2,000 pounds of a mixture containing 2 to 4 per cent nitrogen, 6 to 8 per cent phosphoric acid, and 6 to 8 per cent

potash may be used with profit, the quantity and formula depending upon the richness of the soil and its previous treatment. Schermerhorn [15] recommends 1,000 to 1,500 pounds of 3-8-8 * fertilizer per acre for New Jersey growers.

While manure gives good results when used in small to medium quantities, it is doubtful if its use on sweet potatoes is justified when it is needed for other crops. However, where manure is available for this crop, an application of 8 to 10 tons per acre will be found profitable on soil of low fertility. Results of experiments in Illinois [3] indicate that application in the row is preferable to broadcasting. In these experiments the yield from 10.56 tons of manure was higher than from 600 pounds of a fertilizer consisting of 2 parts steamed bone (12 per cent phosphoric acid), 2 parts dried blood, and 1 part sulfate of potash, or from 538 pounds of steamed bone alone. It should be noted that the manure furnished much more nitrogen and potash than the complete mixture, and that the steamed bone supplied practically nothing but phosphoric acid.

There is considerable difference of opinion regarding methods of applying fertilizers. Experimental results and good practice seem to favor application in the furrow when small quantities, less than 750 pounds, are used. In the Illinois experiments cited, applying both the complete mixture and the steamed bone in the furrow gave higher yields than applying the same quantity

* Three per cent ammonia; 8 per cent phosphoric acid and 8 per cent potassium oxide K_2O.

broadcast, although the difference was not large. When more than 1,000 pounds is applied, broadcasting probably is preferable to drilling in the furrow, or part may be broadcasted and part applied in the furrow. Heavy application in the row may cause burning of the plants. When applied in the row a common practice is to sow the fertilizer in a furrow by hand or to use a row distributor and then to make the ridge over it.

Green Manures and Cover Crops

The practice of growing a green-manure or a cover crop, whenever practicable, is a good one and should be followed in connection with sweet potatoes. After the sweet potatoes are harvested some crop should be planted to supply humus for succeeding crops. In the lower sections of the South cowpeas may be planted after early sweet potatoes, and rye, rye and vetch, or oats and vetch may be sown after the main crop. In some sections, as in Virginia, crimson clover may be sown after early sweet potatoes. Where sweet clover, cowpeas, or other legumes are not practicable following sweet potatoes, rye or oats should be sown. No land should be left bare for many weeks as humus is needed in most soils.

Where a green-manure, or a cover crop precedes sweet potatoes, the land should be plowed some time in advance of planting the potatoes. In case the crop to be turned under is heavy, 3 to 4 weeks should elapse between plowing and planting the sweet potato plants. This will allow the material to decompose sufficiently to prevent injury.

IV

PLANTING AND CARE OF THE CROP

Pulling the Plants

Sweet potato plants are commonly planted soon after a rain. Therefore, everything should be in readiness for the work as soon as planting can be started after the rain ceases. The land should be prepared in advance. To avoid delay in planting the workers should begin to pull plants as soon as practicable after the rain. The plants should be placed in crates, baskets, tubs, or other receptacles for transportation to the field. It is desirable to put some moist material, such as sphagnum moss, straw, or other absorbent, in the bottom of the receptacles and to place the roots on this. A covering of burlap, old carpet or other material should be placed over the tops of the plants to lessen evaporation and transpiration. In pulling the plants the seed root is held down with one hand while the plants are removed with the other. As not all of the plants are ready at any one time only those that are of sufficient size and have formed good roots are pulled. The others are left for later planting. When several plants cling together at the base, they should be separated so as to avoid loss of time in the field. If machines are to be used for planting, it is important to have the plants in the best possible condition to be handled rapidly by the persons

who are to feed them into the machine. The roots should all be kept in one direction, and, if the tops are too long for convenient handling, they may be trimmed off with a sharp knife. After making a pulling of plants, the beds should be watered to settle the soil around the roots of those that are left.

Some growers follow the practice of "puddling" the plants as they are pulled. The plants are taken in small bunches and dipped into a tub of thin paste made of water and clay. This covers the roots with a coating which prevents rapid drying and insures direct contact with the soil when planted. The paste must not be allowed to dry on the roots at the time of planting for a covering of dry clay is a disadvantage rather than an advantage. If it should become dry, dipping the clay-covered roots into a pail of water just before planting will prevent injury. Instead of "puddling" some growers merely dip the bunches of plants in water before planting so that the roots are moist when they come into contact with the soil. When water is used in planting, neither puddling nor dipping in water is necessary.

Time of Planting

There is no best time for planting. This depends upon the locality, the weather conditions, the condition of the soil, and the time the crop is desired. In the northern part of the sweet potato region, as in Kansas, Iowa, Illinois, New Jersey, etc., and for an early crop in the South, it is desirable to plant as early as the weather will

allow. The sweet potato plant is tender to cold. Therefore, planting should be delayed until there is no danger of killing frost. There is no advantage in planting before the weather becomes warm even though the danger of frost is past, since the plants become stunted in cold weather. In most parts of the South, plants for the main crop may be planted any time from late spring until the end of June, and in many sections planting may be made as late as the latter part of July. Stucky [18] reported results of experiments carried on at Griffin, Georgia, for three years, which indicate that for large yields of the Pumpkin-Yam variety in that locality the best time for planting is between May 16 and June 11. His data show that light yields may be expected at Griffin when plants are set after July 1, although in one year a fair yield was obtained from July 15 setting. In regions having a longer growing season later planting would be satisfactory. Good yields need not be expected with less than 4 months of growing season after the plants are set.

Setting the plants just after a rain, when the soil is in good condition, is especially desirable when hand planting is followed. With machine planting setting while the soil is moist is not so important since the machine applies water around the roots without much extra labor, providing a supply of water is near at hand.

Distance of Planting

The spacing of sweet potato plants varies between wide limits depending upon the variety,

the richness of the soil, and other factors. Varieties which produce long vines are given more space than those with short vine growth. In some cases large-growing varieties are planted close together on fairly rich soil in order to prevent the potatoes from getting too large. On the other hand, plants on poor soil need considerable space in order to produce roots of good marketable size. For varieties which produce a heavy growth of long vines, the rows are usually spaced 4 to 5 feet apart and the plants set 12 to 24 inches apart in the row, 15 inches being a common distance. Short-vined varieties, especially those of the bunch type, and weak-growing ones, as the Yellow Jersey, often are planted in rows 2½ to 4 feet apart. In some regions, as in the Eastern Shore of Virginia, plants of the Yellow Jersey are set from 16 to 20 inches apart in rows 30 inches apart. Two slips are sometimes set in a hill, when the spacing is 22 by 30 inches, growers claiming that two plants will produce a more uniform product and more medium-sized potatoes. In New Jersey the rows are spaced 2½ to 3 feet apart with the plants set 22 to 30 inches apart for cultivation both ways. If cultivation is to be given in only one direction the plants are spaced 18 to 25 inches apart in the row. Results of an experiment conducted by the Georgia Experiment Station for one year showed a larger yield from plants set 18 inches apart than for those set 24 or 30 inches apart. Southern Queen and Pumpkin Yam were the varieties used in this experiment. Experiments conducted by the Louisiana Experi-

ment Station for three years gave the following yields per acre for different spacings: 8-inches, 352 bushels; 12-inches, 258.31; 15-inches, 275, and 18 inches, 281.82 bushels of marketable potatoes.

Since the closer spacing requires more plants and more labor for setting, it would seem good practice to set the plants 15 to 18 inches apart where the rows are 4 or more feet apart. Greater space should be allowed between the plants in the row where the rows are closer together.

Method of Planting

Hand Planting—Where only a small acreage of sweet potatoes is grown, hand planting is commonly followed, unless a planting machine can be used for setting other plants. The simplest method and the one generally used is to have the plants dropped on the row by one person, often a child, and to have a second worker set the plant, using a trowel, a dibble, or a sharp stick to make the hole to receive the plant. The plant is inserted in the hole and the opening closed by a second thrust of the tool or by pressing the earth about the plant with the heel of the shoe. If the soil is very dry it is desirable to pour a little water into the hole. This, however, is not essential if the plants have been puddled.

Another method of planting by hand has been developed by growers in Gloucester County, New Jersey. DeBaun [2] describes this method as follows: "In one hand the setter carries a light pair of wooden tongs about 4 feet long. In the other

hand he carries a light stick known as the 'puncher.' The lower end is shaped like a wedge and the upper end extends past the hand about a foot and a half. A loose loop passes around the operator's upper arm so that the stick is more easily and quickly guided. As the operator steps forward, he plunges the 'puncher' into the soil and, at the same time, with wooden tongs, seizes the plant at the lower end of the root. As the puncher is quickly pulled from the hole, the plant is pushed into it with the tongs and the puncher is used immediately to close the hole. The beginner might not be successful, but the experienced man can set plants nearly as fast as one usually walks."

A hand planting machine of the Masters Hand Planter type can be used to advantage in setting sweet potato plants. It has a small tank on the side for water which can be used if desired. By tripping the lever at the top a small quantity of water is applied around the roots, but this method of watering is practicable only on a small scale.

Vine cuttings are always planted by hand. The cuttings are dropped on the row at the place desired and usually are pressed into the soil with a notched stick. The worker places the notch of the stick over one end or over the middle of the cutting and forces it into the soil to the depth of 3 or 4 inches.

With any method of hand setting it is important to press the soil around the plants or cuttings.

Machine Planting—Where sweet potatoes are grown on a large scale a transplanting machine is

PLATE V.—TWO SERIOUS DISEASES OF THE SWEET POTATO

Lower right—Root of Yellow Jersey Showing Blackrot. Upper right—Cross Section of Same. Lower left—Vine Showing Effects of Stem-rot or Wilt Caused by *Fusarium Hyperoxysporum*. Upper left—Cross Section of Root of Yellow Jersey Showing Blackening of Fiber-vascular Bundles Caused by Stem-rot or Wilt. Courtesy of Bureau of Plant Industry, U. S. Department of Agriculture.

PLATE VI.—*Lower left*—A Good Type of Sweet Potato Digger. *Upper left and right*—Two Types of Potato Storage Banks. *Lower right*—A Good Type of Storage House. Courtesy of Bureau of Plant Industry, U. S. Department of Agriculture

often used for setting the plants. These machines open the furrow to receive the plants, apply water, and firm the soil around the plants at one operation. They do the work better and more rapidly than can be done by hand. When the machine is used it is not necessary to wait for a rain as a small quantity of water is automatically poured around the roots of each plant as it is set. Three workers and two horses, or two mules, are required to operate one of these transplanting machines. One man drives and two men, or two careful boys, alternate in placing the plants in the furrow at the proper distances. If water must be hauled a long distance a fourth worker is desirable. For close planting (15 inches) the team must walk slowly and the men or boys must work rapidly to get the plants properly set. The water is applied from a barrel, on the machine, through a hose which ends just in front of the shoes of the transplanter, and at the place the plant is inserted in the furrow. Under favorable conditions a machine will set 3 to 5 acres in a day.

Cultivation

The methods used in cultivating sweet potatoes do not differ materially from those used with other farm and garden crops. In a large part of the South the main crop of sweet potatoes receives less cultivation than other vegetables and in many instances less than cotton or corn. They should, however, be given sufficient cultivation to keep weeds under control. The recommendation

to cultivate once a week, without regard to weeds or to the condition of the soil is a poor one to follow. If the surface of the soil is loose and if no weeds are present, cultivation is not only an unnecessary expense, but is likely to be detrimental through root destruction and deepening of the soil mulch.

When the plants are set on ridges a cultivator, small plow or sweep should be run through the alleys to break out or level down the strip of soil left in ridging. The loose soil is worked toward the rows to make a broad flat ridge. Shallow cultivation should be given as often as necessary to keep weds under control until the vines completely cover the soil. Where the plants are set in check rows, cultivation is given in both directions and this eliminates hand hoeing. When cultivation is in only one direction some hand hoeing is necessary to control weeds between the plants in the row.

Cultivation is done with one-horse cultivators, with sweeps or with gang cultivators drawn by two horses. The sweep is very commonly used in the South, and does very good work where weeds are serious. If, however, the weeds are not allowed to get a start, cultivators with small teeth are satisfactory.

Difference of opinion exists regarding the advisability of moving the vines so that cultivation can be continued late in the season. Some moving of the vines is necessary even before they meet in the centers between the rows. This is not injurious before the vines have rooted at the joints if the

work is done carefully. Many growers turn the vines from one row to the other and continue cultivating after the vines cover the soil. Experimental results in Georgia and in Arkansas indicate that disturbing the vines after they have rooted at the joints is injurious. In the Georgia experiment, carried on for one year and reported by Starnes,[17] one set of plants was allowed to grow without being moved for cultivation, while in another set the vines were loosened once each week where they had rooted. The plants that were not disturbed yielded at the rate of 270.3 bushels per acre, while those not allowed to root produced only 156.3 bushels per acre. Newman [11] reported results of 2 years of work in Arkansas in which vines moved for cultivation produced 166 bushels, while those not moved yielded 170.85 bushels per acre; vines lifted once a week produced 160.50 bushels and those not lifted produced 169.45 bushels per acre. Where the vines were moved for cultivation two more cultivations were given than when they were not disturbed.

Considering the results of experiments and the observations of the practice of many growers, it seems safe to say that moving the vines after they have become rooted at the joints is not justified and is likely to result in reduced yield. After the vines cover the soil, cultivation is of little or no value as far as the soil mulch is concerned for the vines themselves act as a mulch.

Irrigation

While the sweet potato produces a fair yield

in regions of scant rainfall, irrigation is profitable in semi-arid and arid regions. Garcia [5] reports that 6 to 10 irrigations have produced large yields in New Mexico. He states that light irrigation at frequent intervals is preferable to heavy irrigation at less frequent intervals. Most of the water should be applied between the time the plants are set and the vines cover the ground. Applications of water late in the growing season are likely to produce excessive growth of vines. On the subject of irrigation in California, Rosa [14] writes as follows:

"Most of the sweet potatoes in California have hitherto been grown on sub-irrigated land in the Stanislaus-Merced district with the water table 4 to 5 feet below the surface during the growing season. With the lining of the canals to prevent seepage and the pumping being carried on in some districts to lower the water table, it probably will become necessary to resort to surface irrigation. The crop can be grown very successfully with surface irrigation (by the furrow method) but the cost is greater than under sub-irrigated conditions. Where sweet potatoes are to be surface-irrigated, the land should be graded carefully and the water handled so as to get as even a distribution as possible. During the dry season of 1924 many fields received emergency irrigations and it was found that in those portions of the fields where too much water was recieved the potatoes were over-sized and rough, and many of them cracked.

"Even more important is the relation of soil moisture to disease. During 1924, the portions

of the fields that were rather dry or that received only a moderate amount of water were fairly free from the black rot disease. In the lower and excessively moist portions of the fields a very large proportion of the potatoes were affected with black rot. Careful and uniform distribution of water will do much to lessen the losses caused by this disease.

"On sub-irrigated land two surface irrigations usually are given shortly after transplanting. On the higher lands, about seven irrigations during the growing season are required."

Pruning the Vines

When vine cuttings are used for growing sweet potatoes the plants from which the cuttings are taken often are pruned severely. Growers have raised the question as to whether or not this pruning has any marked effect on yield. Some believe that the yield is reduced, and others that it is increased by the pruning. In fact, some growers have followed the practice of pinching back the vines, believing that keeping down foliage growth stimulates the development of the roots. This belief is based on an erroneous assumption. Results of experiments by Garcia [5] in New Mexico and by Starnes [17] and Stucky [18] in Georgia show quite conclusively that pruning back the vines is injurious. In general, the injury is in proportion to the severity of the pruning. In New Mexico the experiments were carried on for two years with results as follows: Hills pruned back to 12 inches in diameter produced 6,012 pounds per acre, those

pruned back to 24 inches produced 8,690; those cut back to 36 inches yielded 10,857 pounds, and plants not disturbed produced 16,520 pounds of potatoes per acre. Results were as striking in the Georgia experiments as in those carried on in New Mexico.

Pruning is certainly not to be recommended, except for the purpose of getting cuttings for planting and even then it is advised to prune as early and as little as is practicable.

V

VARIETIES AND IMPROVEMENT

At least 200 names are given to the varieties of sweet potatoes grown in the United States, but it is safe to say that not over 40 true varieties are to be found in this country. Only 10 of these varieties are of any commercial importance and 4 of them constitute perhaps 90 per cent of the commercial crop. It would be to the advantage of growers, dealers, and consumers if three-fourths of the varieties were eliminated, and only those kept that have distinct merit.

Classification of Varieties

From the foregoing it is readily seen that there is great confusion in the nomenclature of sweet potato varieties and, hence, need for a system of classification and identification. Various attempts have been made at classification, the most recent and perhaps the most complete as well as the simplest is the one published by Thompson and Beattie.[56] The study on which this classification is based was carried on for over twenty years and the varieties were grown in several sections of the United States. It has been found that all varieties that have been grown can be grouped into eight well-defined groups. By means of a simple key, the group to which any variety

belongs can be determined readily and easily. Each group has been given the name of the most widely-known variety, or the variety that is the most typical of the group. Three of the large groups have been divided into sections to simplify the procedure of identification. In naming varieties the name selected is the one in most general use.

Key to Groups—The key to the groups is as follows:

I. Leaves deeply lobed or parted (1 and 2):
   1. Leaves with deep purple stain at base of leaf blade—Ticotea group.
   2. Leaves without purple stain at base of leaf blade—Belmont group.

II. Leaves not deeply lobed or parted (1 and 2):
   1. Leaves with purple stain at the base of leaf blade (A and B):
      A. Stems purple, or greenish with a decided tinge of purple—Spanish group.
      B. Stems green (a and b).
         (a) Leaves entire to slightly shouldered; roots white—Shanghi group.
         (b) Leaves toothed with six to ten low, marginal teeth, or entire; roots salmon, or yellow tinged with salmon—Florida group.
   2. Leaves without purple stain at the base of the leaf blade (A and B):
      A. Stems purple—Southern Queen group.
      B. Stems green (a and b).
         (a) Stems medium to large in size; roots fusiform, yellow tinged with salmon

with light yellow veins—Pumpkin group.

(b) Stems slender; roots russet-yellow or red, ovoid to fusiform—Jersey group.

Description of Groups

In the description of the groups effort was made to give the characteristics of the vines and roots of the entire group rather than of any particular variety. In fact, the group description was made from the description of the varieties belonging to the group.

Ticotea Group—Vines long, 6 to 12 feet, or short and stocky; stems green in color or with a tinge of purple at the nodes, nearly smooth; leaves very angular in outline, 5 to 7 lobed; blade hairy only on the veins of the upper surface, green except for a deep purple stain at the base of the blade and the summit of the petiole; the latter otherwise green, hairy, or nearly smooth. Roots white, smooth, without veins or ribs, varying from fusiform to cylindrical in shape, of medium to large size; flesh white, but dull or grayish white or light yellow when baked, only slightly sweet, quite dry and mealy, and firm in texture. Flavor not pronounced.

The Ticotea group contains only two varieties, Ticotea and Koali, and is not important.

Belmont Group—Vines medium to long, 4 to 12 feet, or very short, 1 to 3½ feet; stems slender or thick and coarse, green, hairy, or smooth to nearly smooth; leaves deeply 5 to 7 lobed, upper surface of blade hairy to nearly smooth, lower

surface smooth or slightly hairy along the veins, green in color; petiole also green, hairy, or smooth. Roots light salmon, yellow tinged with salmon, russet yellow, or rose to purple; veins often prominent and always lighter in color than the rest of the surface; the roots usually fusiform, smooth except for the veins, of average size; medium to late in season; flesh white, yellow, light salmon to dark salmon in color, but light yellow, dark yellow, or yellow tinged with salmon when baked, sweet to very sweet, and so moist that sirup can be squeezed out with slight pressure; flavor somewhat squashlike; texture soft or at times rather coarse and stringy.

The Belmont group may be divided into two sections, as follows:

Belmont section: Vines long and creeping.

Bunch section: Vines very short and bushy.

The stems of the varieties of the Belmont section are long and slender, from 6 to 12 feet in length; or medium in length, 4 to 8 feet, with internodes 2 to 4 inches long. The leaves are rather small, with narrow lobes, except that those of the Eclipse Sugar "yam" and Vineless Pumpkin "yam" are larger, with broad ovoid lobes. The following varieties belong to the Belmont Section:

(1) Belmont. (This variety or very slight variations of it is known under the names Georgia and Dunton's Improved.) (2) Eclipse Sugar "yam." (3) Vineless Pumpkin "yam." (4) Old Time "yam." (5) Yellow "yam." (6) White Sealy.

The stems of the Bunch section are thick and coarse and from 1 to 3½ feet long, with internodes one-third to one-half an inch long, the leaves being greatly crowded in consequence, and it follows that the total leaf surface of a Bunch vine 18 inches long is nearly or quite equal to that of a Belmont vine 11 to 12 feet in length. The leaves resemble those of the Eclipse Variety in being large, with broad ovoid lobes.

This section contains only two varieties:

> Gros Grandia and Bunch Candy "yam," also called Bunch "yam," Vineless, Prolific, and Gold Coin.

Spanish Group—Vines medium in length, 4 to 10 feet, or long 6 to 15 feet (vines of Red Brazil and Creola sometimes grow to be 20 feet long), or short and bushy, 2 to 3 feet, coarse, dark purple in color or green with purple tinge, hairy (especially at the nodes) or smooth; leaves deeply shouldered to entire, green except for a deep purple stain at the base of the blade and the summit of the petiole. The color may extend up the veins, hairy on the upper surface or only on veins, or smooth, the under surface smooth or slightly hairy; petiole green tinged with purple toward the summit, or deep purple. Roots red, yellow, russet yellow, or yellow tinged with rose, usually very irregular, being strongly ribbed and veined, or smooth; fusiform, ovoid, or long cylindrical in shape; medium to very large in size, ripening either early or late. Flesh white, yellow, dull yellow, cream, salmon yellow, or dark yellow.

When baked, slightly sweet to very sweet, moist to dry and mealy, firm, or soft in texture. Flavor caramellike, but not pronounced.

The varieties in the Spanish group may be separated into three sections, as follows:

(1) Yellow Spanish: Roots light yellow to russet yellow.
(2) Bermuda: Roots light yellow, yellow tinged more or less with rose or deep rose.
(3) Red Spanish: Roots dark red to purple.

In the Yellow Spanish section the roots are light yellow in color, usually very irregular, strongly ribbed and veined, but sometimes fairly smooth and regular; flesh white or yellow. The earliest varieties are contained in this sections, being listed as follows:

(1) Pierson. (This same variety or variations of it is known under the names of Arkansas Beauty, California Golden, Early General Grant, Golden Skin, and Dutton's Early.) (2) Yellow Strasburg (also called Extra Early Golden and Adams.) (3) Yellow Spanish (also called Bronze Spanish.) (4) Triumph.

The roots of the Bermuda section are light yellow, more or less overlaid with transverse dashes and bands of rose, sometimes washed with rose, or deep rose to purple, usually very irregular, strongly ribbed, and veined; but some varieties are quite smooth and regular. The varieties are medium early, being listed as follows:

(1) Red Bermuda (also known as Cuba "yam," Poreland, Yellow Red.) (2) Red Brazil or Red Brazilian. (3) Porto Rico (also called Golden Beauty and Key West "yam.") (4) Key West "yam." (5) Creola.

Roots of the Red Spanish section are more regular and are not constricted; the flesh is white, tinged with purple beneath the skin and at the center. The section contains the following varieties:

(1) Red Spanish (also called Black Spanish.) (2) Purple "yam," or Nigger Choker. (3) Dahomey.

Shanghai Group—Vines medium to long, 5 to 8 feet; or long, 8 to 16 feet; stems coarse and thick, green in color and hairy, especially at the nodes; leaves large, entire, or sometimes shouldered, hairy at first, but later smooth except for scattered hairs on the veins above, green except for a deep-purple stain at the base of the blade and the summit of the petiole. The purple color runs to the larger veins of the leaf to some extent; petioles green except at upper end, hairy to some extent. Roots white in color, smooth, and regular or veined and ribbed, long cylindrical to fusiform in shape, medium to large in size, and very late in season; flesh yellow or dull grayish white. When baked, only slightly sweet, dry, and mealy, and rather firm in texture. Flavor not pronounced.

The Shanghai group contains the following varieties:

(1) Shanghai (also called Early Golden and California.) (2) Minnet "yam."

Florida Group—Vines medium to long, 4 to 10 feet; stems rather coarse and thick, green, smooth or somewhat hairy at the nodes, or they may be hairy all over; leaves entire or toothed, with 6 to 10 low marginal teeth, hairy or smooth, except for scattered hairs on the veins on the upper surface, green except for a deep-purple stain at the juncture of the blade and the petiole, this color passing to the large veins of the leaf and down the petiole a short distance; petiole otherwise green and smooth or somewhat hairy; roots light yellow tinged with salmon; veins when present lighter in color than the rest of the surface, short to long, fusiform in shape, of medium to large size, season medium; flesh yellow or yellow tinged with salmon to dark salmon, but light yellow to dark orange yellow when baked; sweet to very sweet, and sugary, very moist to quite dry; the texture soft and melting or sometimes rather coarse; flavor good.

The following varieties belong to the Florida group:

(1) Florida (also called Arizona Prolific and Providence.) (2) General Grant Vineless. (3) Nancy Hall.

Southern Queen Group—Vines large and vigorous, long, 6 to 12 feet; the stems thick and coarse, dull purple in color, hairy throughout the length, somewhat hairy at the nodes and on new growth, or smooth; leaves shouldered or sometimes entire, slightly hairy above, smooth be-

neath, green; petiole greenish purple and nearly smooth or hairy (especially at the base). Roots white or light yellow and sometimes very slightly tinged with pink around the upper end, fairly smooth and regular, or somewhat ribbed and veined, globular or short fusiform in shape or long fusiform; medium to large in size; season medium. Flesh light yellow, sweet, very moist to fairly dry, soft in texture, or very fibrous; flavor good. The following varieties belong to the Southern Queen group:

(1) White "yam."
(2) Southern Queen (this variety, or slight variation of it, is known under the following names: California "yam," Arkansas Hybrid, Brazilian, Cuban, Common "yam," Hayman, Johnson's Bahama, Kentucky White, McCoy, Polo, Vestal's Newark, Miles "yam," Archers' Hybrid, Hamburg, Caroline Lee, Cullman Cream "yam," Hanover, Catawba White, and Ballinger's Pride.)

Pumpkin Group—Vines long, 6 to 15 feet; stems small to average size, green, slightly hairy (especially at the nodes and on new growth); leaves low, shouldered, or entire with 4 to 10 low marginal teeth, hairy on the upper surface of the blade and smooth beneath, green; petiole green, slightly hairy (especially near its base). Roots yellow, tinged with salmon, fusiform to cylindrical in shape, veined prominently and often slightly ribbed, the veins light yellow in color; medium to large in size, season late. Flesh yellow to deep

orange-yellow. When baked, sweet to very sweet, very moist and soft in texture, flavor distinctly like squash.

The Pumpkin group contains the following varieties:

(1) Pumpkin "yam." (Early Yellow, or Spanish "yam.") (2) Norton. (3) Dooley. (4) White Gilke.

Jersey Group—Vines low and slender to large in growth, very short, 1 to 2½ feet; or long, 6 to 15 feet; stems very slender to thick and coarse, green, hairy (especially at the nodes); leaves shouldered to entire (both extremes may be found on the same vine), green, sometimes a very slight tinge of purple may be found at the juncture of the blade and the petiole especially in the Red Jersey section, smooth or hairy on the upper surface of the blade, slightly hairy, or smooth beneath; petiole green, hairy (especially at the lower end). Roots red or russet yellow in color, usually very regular in shape, smooth or veined more or less, short to long fusiform or even globular, small to large in size, season early to late; flesh light yellow to dark yellow. When baked, fairly sweet, usually very dry and mealy, and quite firm in texture.

The Jersey group contains the varieties usually found on the Northern markets. These may be divided into the following sections:

(1) Roots red ..... Red Jersey
(2) Roots russet yellow:

Stems short and bushy ..... Bush
Stems long:
Stems medium to large .....
Big-Stem Jersey
Stems slender ..... Yellow Jersey

Varieties of the Red Jersey section have stems varying from slender to coarse, often fasciated; roots light russet, red, or dark red, medium in size, usually fusiform or ovoid, sometimes globular in shape; season medium to late; flesh golden brown. When baked, sweet, dry and mealy; quite firm in texture.

The following varieties belong to the Red Jersey section:

(1) Japan Brown. (2) Red Jersey (also called Connelly's Early Red, Early Red Carolina, Red Nansemond, and Van Ness Red.)

The stems of the Bush section are very short, 1 to 2½ feet, rather thick and coarse, with very short internodes and crowded leaves, the internodes one-third to one-half inch long; leaves hairy on the upper surface, but more shining than those of the Yellow Jersey section, usually entire or slightly shouldered; roots russet yellow, fusiform to ovoid in shape, medium in size, season medium; flesh yellow. When baked, the flesh is fairly sweet, dry, and mealy, quite firm in texture.

The Bush section contains but one variety:
Vineland Bush (also called Georgia Buck "yam" and Vineless Bunch Nansemond.)

In the Big-Stem Jersey section the vines are

moderately large growing, long, 6 to 12 feet; stems rather thick and coarse, often fasciated; leaves larger than those of the Yellow Jersey section, strongly shouldered to entire. Roots russet yellow, often strongly veined, but otherwise smooth and regular, usually fusiform in shape, but inclined to become ovoid, medium to large in size, season medium, flesh light yellow. When baked, the flesh is usually very dry and mealy and quite firm in texture; flavor chestnutlike. The Big-Stem Jersey section contains the following varieties:

(1) Big-Stem Jersey, sometimes called Florida and Improved Big Stem.
(2) Philipili.

The Yellow Jersey section has vines that are very small and slender to moderately large in growth, long, 6 to 12 feet, stems slender, often fasciated. Roots russet yellow, smooth and regular, or with low veins, fusiform or globular in shape, small to medium in size, season medium; flesh light yellow to salmon. When baked, usually very dry and mealy and quite firm in texture. The Yellow Jersey section contains the following varieties:

(1) Yellow Jersey (other names given to this variety or selections of it are the following: Early Bloomer Nansemond, Big Leaf, Early Carolina, Early Yellow Jersey, Kelly's, McCoy's Sweets, Red Nose, Nansemond, Yellow Nansemond, Up River, Cedarville).
(2) Gold Skin.

Description of Important Varieties

Since many of the varieties are of little importance it seems wise to limit the descriptions to those that are fairly common. Of these varieties the most important commercial ones are Yellow Jersey, Big-Stem Jersey, Nancy Hall, and Porto Rico. The first two are the most important in the North and the last two are the most important commercial varieties grown in the South. Other varieties of considerable importance in some sections are Triumph, Southern Queen, Dooley, Pumpkin Yam, Red Jersey, Gold Skin, and Belmont or Georgia.

Yellow Jersey—Vines small, slender, long, 6 to 12 feet; stems green, hairy, often fasciated; leaves shouldered or entire, hairy only on the upper surface, green; petioles green, hairy; roots dark russet yellow, long or short, fusiform to globular or ovoid in shape (two types known on the market, one long fusiform and another very short), smooth or veined; small to medium in size; season medium, flesh yellow. When baked, very dry and mealy, fairly sweet; texture quite firm.

This variety is probably the most important one grown for market in New Jersey, Delaware, Maryland, Virginia, Illinois, Iowa, and Missouri. The Yellow Jersey, and others of the Jersey Group, are in demand on northern markets where a so-called dry, mealy potato is desired.

Big-Stem Jersey—Vines moderately large growing, long, 6 to 12 feet; stem green, hairy; leaves shouldered or entire, hairy above and smooth beneath, green; petiole hairy, green; roots russet yellow in color, smooth and regular, long fusiform in shape, may

be veined or smooth, small to large in size, but larger than Yellow Jersey or Red Jersey; season medium to late; flesh yellow. When baked, sweet, dry, and mealy; texture firm.

Gold Skin—Vines medium to long, 6 to 10 feet; slender, hairy (especially at nodes); green in color; leaves shouldered or entire (both forms may be found on the same vine), light green, hairy above, slightly hairy beneath; petioles short, slender, hairy, green, except for slight tinge of purple at the base of the leaf blade; roots dark russet yellow, fusiform in shape, smooth and regular; season medium; flesh salmon, but a dark yellow when baked; medium dry and mealy, very sweet; texture firm.

Nancy Hall—Vines medium in length, 4 to 8 feet; stems somewhat hairy, green; leaves toothed or entire with 4 to 10 low marginal teeth, hairy on the upper surface and slightly hairy or smooth beneath, green except for a reddish purple stain at the juncture of the blade and the petiole, the latter slightly hairy, green except at the upper end; roots yellow, tinged more or less with salmon, veined, or smooth and regular, fusiform in shape, medium to large in size; season early; flesh dark yellow, tinged with salmon. When baked, very sweet, moist and soft in texture; good quality.

This variety is probably grown commercially in the South more than any other, but is being replaced to a considerable extent by the Porto Rico.

Porto Rico—Vines medium to long, 5 to 10 feet; stems coarse, internodes short, reddish purple in color, hairy (especially at the nodes and on young growth); leaves shouldered, large in size, green except for a purple stain at the base of the blade and on the veins, slightly hairy on the upper surface, smooth below; petioles medium long, 5 to 8 inches, reddish purple

in color, deeper at the base of the leaf blade, color extends to the veins on the lower side of the leaf and also deeper at the base of the petiole; roots generally light rose in color, but a bud sport which is golden yellow in color has been introduced recently, fusiform to globular and irregular in shape, smooth; flesh orange yellow to salmon, but dark yellow when baked; moist, very sweet, good quality.

This is one of the most popular varieties in the South, especially where it is well known.

Dooley—Vines long to very long, 10 to 15 feet; stems green, slightly hairy (especially at nodes); leaves shouldered or often entire, green in color, hairy above and smooth beneath; petioles green, slightly hairy; roots large in circumference, short fusiform in shape, yellow to salmon in color; flesh dark orange. When baked, soft and sweet, squashlike.

Southern Queen—Vines large and vigorous, long, 6 to 12 feet; stems dull purple, slightly hairy (especially at the nodes and on new growth); leaves shouldered or entire, slightly hairy above, green; petiole nearly smooth, greenish purple. Roots white or light yellow, sometimes very slightly tinged with pink, smooth and regular, few or no veins, fusiform, globular or ovoid in shape, medium to large; season medium; flesh light yellow. When baked, sweet, moist, and soft in texture.

Pumpkin Yam—Vines moderately large growing, long, 6 to 12 feet; stems green, hairy; leaves low, shouldered, hairy only on the upper surface, green; petioles green, hairy; roots yellow, tinged with salmon, mostly irregular with prominent light yellow veins, some smooth and regular with few or no veins, fusiform in shape, medium in size, season late; flesh dark orange-yellow. When baked, very sweet, moist, and soft in texture.

Belmont or Georgia—Vines slender and low, long creeping, 6 to 12 feet; stems light green, hairy; leaves 5-parted with basal lobes inclined to shoulder, hairy above and upon the veins beneath, light green; petiole hairy, green; roots dark yellow with prominent light-yellow veins, fairly smooth and regular, long fusiform in shape, medium in size; season late; flesh golden yellow, but dark yellow when baked, sweet, moist, and soft in texture.

Misuse of the Term Yam

In common parlance the term yam is used to designate any moist-fleshed variety of sweet potatoes, although southern growers use the term for cetrain types grown in the South. However, there is little agreement among growers in the various sections of the South as to which varieties should be called yams. It is unfortunate that this term has been used for sweet potatoes since the name belongs to another plant which is not even closely related to the sweet potato. The true yam belongs to the *Dioscoreaceae* or yam family and is known to botanists under the generic name *Dioscorea*, of which there are several species, while the sweet potato is known as *Ipomoeae batatas*, a member of the *Convolvulaceæ* or morning glory family.

Choosing Varieties

In choosing varieties the grower should consider the purpose for which the crop is grown, whether it is intended for home use or for market. If the crop is grown for home use only the preference of the family should be given considera-

tion. When grown for sale, the demands of the particular markets to be supplied must be considered. In the markets of the South, the Porto Rico and Nancy Hall are the most popular. According to Gatlin [60] in the eastern markets, north of Virginia and east of the Ohio River, the Jersey type is preferred and there is no decided preference for any one southern variety. "In the central and northern markets—north of Tennessee and east of the Mississippi the Nancy Hall is the most popular southern variety. Jersey type stock is preferred, but the preference is not so positive as in the East. West of the Mississippi River the Nancy Hall is the favorite, but the preferences are not so firmly established as in other sections."

It should be noted, however, that the Porto Rico has been gaining rapidly in popularity for the past 8 or 10 years.

The writer is of the opinion that the preference for the dry-type of sweet potato in the markets of the North is due largely to the facts that the consumers are accustomed to that kind, and that most of the stock shipped from the South had been poorly graded and packed, and, therefore, was very unattractive to the buyer. The demand on nearly all markets is for a uniform product of medium size.

Gatlin [60] reports that from 90 to 99 per cent of the car-lot shipments from Georgia, South Carolina, Louisiana, and Texas are the Porto Rico. From 90 to 95 per cent of the car-lot shipments from Tennessee, Arkansas, and Oklahoma

are the Nancy Hall. In Alabama the principal varieties shipped are Triumph, Porto Rico, and Nancy Hall, the Triumph being grown almost entirely for shipping to the northern markets during the summer. Porto Rico is the most important variety in Florida. In North Carolina the Porto Rico, Nancy Hall, and Southern Queen (Hayman) are the principal southern varieties shipped, while in Louisiana the Dooley is the principal variety. In all of the northern sweet-potato growing regions varieties of the Jersey type are the most common.

Bud Sports

The presence of red and yellow sweet potatoes on the same vine has often been observed by the writer. More rarely a potato is found which is red on one side or on one end and yellow on the other. This phenomenon has also been observed by farmers and some have mentioned this as evidence of crossing or hybridization, although propagation was entirely by vegetative means. Harter [6] recently has called attention to bud sports in the variety Haiti, which normally produces red roots. In 1923 he found one plant of this variety which produced three red and three yellow roots. All of the potatoes from this hill were bedded in the greenhouse in the fall of 1923 and they produced in all about 25 plants of each strain. These plants were set in the field in 1924 and each strain produced about a peck of potatoes. The reds produced only red potatoes and the yellows only yellows. The following year all of the

potatoes from each lot were bedded and 100 plants taken from each and set out. Nearly two bushels of each lot were produced, the reds producing only reds and the yellows only yellows, as in the previous year.

It is not known where or how the variety Haiti originated, that is, whether as a bud sport, a mutation, or as a result of hybridization. However, since the particular strain in which Harter found the hill in 1923 had been propagated by vegetative means for 12 years in a region where flowers are seldom produced and seeds never, it is, in all probability, not the result of hybridization.

Another recorded instance of bud sports in sweet potatoes is found in Coker's Pedigreed Seed Company's catalog for 1927 (p. 29). This bud sport was found in the variety Porto Rico and the origin of the sport is given as follows:

"In our 1920 Hill-to-row [test] of Portorican sweet potatoes a single hill was found, produced from a single plant, one side of this plant was golden, the other side a deep red. The buds on the golden side of the plant produced two potatoes with clear skin, red eyes, and rich yellow meat. The red side of the plant produced typical Portoricans. Each potato was bedded separately. Plants from the golden potatoes produced only potatoes of the same variety, plants from the red potatoes continued to vary."

The writer saw specimens of this so-called Golden Porto Rico in the spring of 1927, and these were very attractive in appearance. The

flesh of the specimens examined was of the same general appearance as that of the Porto Rico, but the skin was a rich golden yellow color.

Improvement

The sweet potato seed stock in many regions is badly mixed. It is not uncommon to find roots of more than one variety in the same market package. This condition is due to carelessness, since there is practically no chance for anything but mechanical mixing. Any grower, by carefully sorting his own seed roots, can eliminate all that do not belong to the variety he desires to grow. Growers should not only be sure of getting a good variety suitable for the market to be supplied, but they would do well to get the best strains of the shape and size most in demand. For example, the New York City market prefers a short, chunky Yellow Jersey rather than the long spindle-shaped potato. Growers of this variety in New Jersey, have, by selection, developed a short, chunky Yellow Jersey to meet this preference.

In the United States improvement by selection is the most practical method since the sweet potato seldom produces seed, even in the lower portions of the South.

The improvement brought about through hill selection by practical growers indicates the possibility of this type of work. The selection should be done in the field at harvest time so that the entire plant can be considered. The vigor of the plant, the yield, the size and shape of the roots,

and the resistance of the plant to disease should be given careful consideration. The grower should have an ideal in mind and then select hills most nearly meeting that ideal. In general, the hills selected should be free from serious disease and produce a good yield of smooth roots of the shape and size desired. Where stem-rot is found each hill selected should be tested by splitting the stem. Potatoes should not be saved from any hill showing black streaks for this is evidence of stem-rot. A heavy frost will produce a similar appearance, hence, it is desirable to select the seed before the vines are killed.

In ordinary hill selection all hills selected are commonly thrown together and used for propagation the following year, without regard to the future performance of each hill. It would be much better to plant each hill separately in a row for further study and selection. This is known as the hill-to-row method and makes it possible to eliminate hills which do not maintain the standards of the parent hills. A better method is the one known as tuber-unit selection in Irish potatoes. This method is based on the fact that potatoes within the hill vary just as do hills within the strain. By this method, which might be called the root-unit method, seed is saved only from such units as maintain the desirable characters. A unit in this case would consist of plants produced from a single seed root. None of these methods require annual selection of hills or units from the main field, since after the initial selections are made all further efforts are confined to the seed plants. By means of the root-unit method

advantage can be taken of bud sports as has been done with citrus fruits and as Coker's Pedigreed Seed Company has done in the case of the so-called Golden Porto Rico sweet potato.

In addition to improvement by selection, there is opportunity for crossing and hybridizing. This is a promising method in regions where the sweet potato produces seed under natural conditions. Even in regions where seed is not produced under natural conditions, it is possible to produce them under controlled conditions in the greenhouse. Results of studies by Stout [55] and Thompson [57] and others indicate that most seedlings and most clonal varieties are self sterile. Stout states that various combinations in cross-pollination likewise fail, but certain compatible relations are to be found which readily yield fruits and seeds.

Seed Certification

Within recent years sweet potato seed certification has been developed in a few states. In most, if not in all cases, inspection and certification are in the hands of public agencies as the state agricultural college, the state department of agriculture, or the state plant board. The aim in most of this work is to reduce or eliminate dangerous diseases and insect pests, to eliminate variety mixtures, and to encourage the use of the best varieties and strains. Considerable progress has been made in seed certification in a few states. The grower is advised to get in touch with the county agricultural agent in his county or the state agricultural college in his state to find out whether or not certified seed is available.

VI

DISEASES AND INSECTS

Diseases and insects attacking the sweet potato are given relatively little attention by growers in most sections, in spite of the fact that large losses are caused by them. Harter [25] describes fourteen diseases affecting the sweet potato. All of them are not likely to be found on any farm, but it is exceptional to find a crop that is not injured by some disease.

Diseases

Sweet potatoes are attacked by diseases in the field and rots in the storage. The diseases attacking the crop in the field may be divided into root and stem diseases, and leaf diseases. Stem-rot, black-rot, foot-rot, scurf, and root-rot affect the stems and roots, while leaf-blight, leaf-spot, and white-rust attack the foilage. According to Harter leaf diseases have never been serious enough to require remedial measures.

Storage rots include soft-rot, ring-rot, black-rot, Java black-rot, and charcoal-rot. Losses by these diseases are heavy in storage, but may be considerably reduced by careful methods of handling and good storage conditions.

Stem-rot—This disease is caused by *Fusarium batatatis* and *F. hyperoxy-sporum.* It is found in

nearly all states where sweet potatoes are grown. The first indication of the disease in the field is a change in the color of the leaves, which become dull in color, then yellowed between the veins, and somewhat puckered. Wilting of the vines then follows and the newer leaves usually show the disease first. The diseased stems become blackened inside and this discoloration may extend from 3 to 5 feet from the hill. The stems later break open and the surface becomes blackened and rotted. The organism also may invade the roots, forming a blackened ring a quarter of an inch below the surface. Sprouts grown from infected potatoes are likely to be diseased.

Stem-rot fungus lives over winter in the soil on dead sweet potato vines and in the potatoes in storage. It is, therefore, important to use only healthy seed and not to plant in heavily-infested soil. The organism can live for several years in the soil on decayed plant remains so that a short rotation is of little value. The infection takes place through the roots, either in the plant bed from plants grown from diseased seed or in the field after the plants are set. Plants infected when set in the field soon die. The spores of the fungus may be carried by the wind, insects, farm implements, animals, drainage water, and other means.

The control measures recommended are seed selection, sanitation, and the use of vine cuttings in growing seed. Seed selection should be done at harvest time and while the potatoes are still attached to the vines. The stem should be split and potatoes saved for seed only from vines showing no black streak in the stem. In the spring potatoes showing any disease should not be used for seed purposes. Disinfecting the seed with a solution of corrosive sublimate as described on page 26 will kill any stem-rot spores on the surface. The use of clean sand in the plant bed

and disinfecting the frame of the bed and the ground around it will also aid in controlling this disease. A solution of formaldehyde made by mixing 1 pint of commercial formalin and 30 gallons of water, or 1 pound of copper sulfate dissolved in 25 gallons of water, may be used as a disinfectant. Spray the bed and the soil around it with one of these solutions and repeat the treatment after 24 hours.

The use of vine cuttings free from stem-rot has been found to be an aid in controlling this disease. The cuttings should be planted on land free from the stem-rot organisms and the potatoes produced from them given the treatments already recommended.

While crop rotation is a desirable cultural practice, it cannot be depended upon to control stem-rot. Poole [38] mentions one instance where plants from selected seed were planted on land which had not been in sweet potatoes for 12 years. The infection was estimated at 65 per cent.

Black-rot—This disease is caused by the fungus *Ceratostomella fimbriata*, which may attack any underground part of the plant. It causes heavy losses both in the field and in storage. Poole [37] reports losses as heavy as 75 per cent in storage due to unsanitary houses and poor management. On the potato the rot occurs as circular moist, smooth, dark brown to nearly black spots. In the early stages the spots are small, but under favorable conditions they enlarge and frequently cover nearly the whole potato. On the stem the infection begins as small black spots which gradually enlarge until the stem is rotted off. Plants grown from potatoes infected with the black-rot will likely have this disease. The young plants usually turn yellow, wilt, and die in the field.

The same control measures suggested for stem-rot are recommended also for black-rot. Poole [37] sug-

gests digging the potatoes early where the outbreak of black-rot is serious. At digging time, and again before bedding, all potatoes showing cuts, bruises, or signs of disease should be discarded. A rotation covering 3 or 4 years, or even longer, is recommended. Black-rot loss in storage is greater in bins than in crates, baskets, or other small containers. Hence, where practicable, bin storage should be discarded.

Foot-rot—The fungus causing this disease is *Plenodomus destruens*. The infection takes place mainly through the roots and other underground parts of the plant. The disease appears at first as small, brown to black spots on the stem near the ground. Its growth is very slow in the beginning, but, eventually, it girdles the plant and may extend up the stem 4 or 5 inches. Soon after the plant is girdled wilting begins and round black-fruiting bodies, just visible to the naked eye, appear in the diseased areas. The organism may grow from the stem to the roots and cause a brown, rather firm spot on the potato. Later, fruiting bodies develop on the surface in the form of pimple-like protuberances. According to Harter [25] this disease is not as widespread as stem-rot or black-rot, but is known to occur in Virginia, Ohio, Iowa, and Missouri. In localities where it does occur it causes greater losses than either of the other two diseases mentioned.

The same control measures should be used for this disease as for stem-rot and black-rot.

Scurf—This disease is known also as soil-stain, rust, and Jersey mark, and is caused by the fungus *Monilochaetes infuscans*. The scurf organism produces brown or blackish spots on the underground parts of the potato. It occurs only on the surface and may be scraped off with the finger-nail. It is very widespread, but the loss is relatively small, although

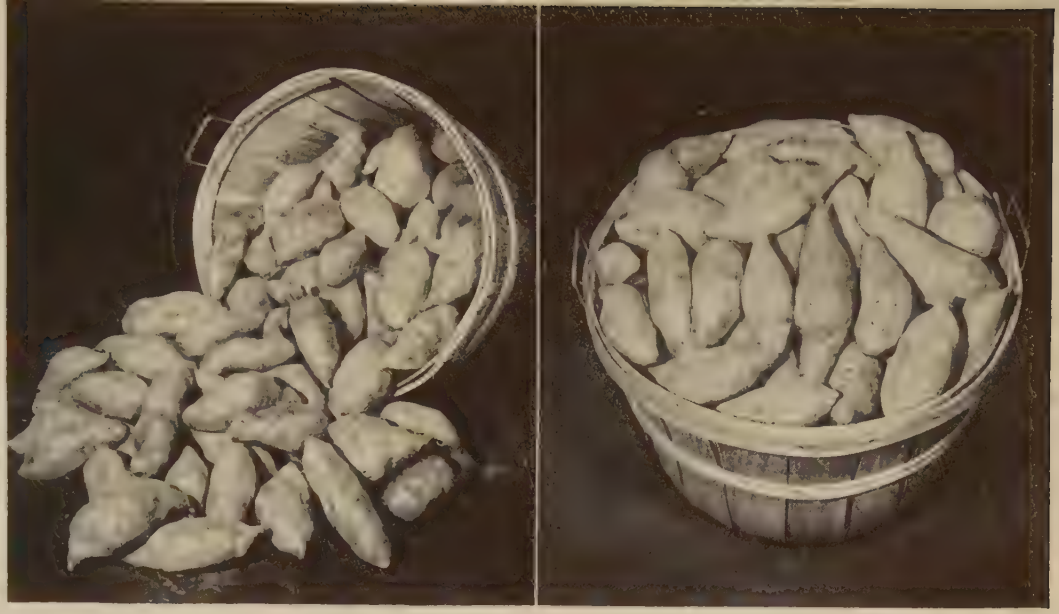

PLATE VII.—WELL-GRADED SWEET POTATOES; U. S. GRADE 1

Right—Basket Properly Packed. *Left*—Potatoes Dumped to Show Uniformity of Potatoes Throughout Basket. Courtesy Bureau of Agricultural Economics, U. S. Department of Agriculture

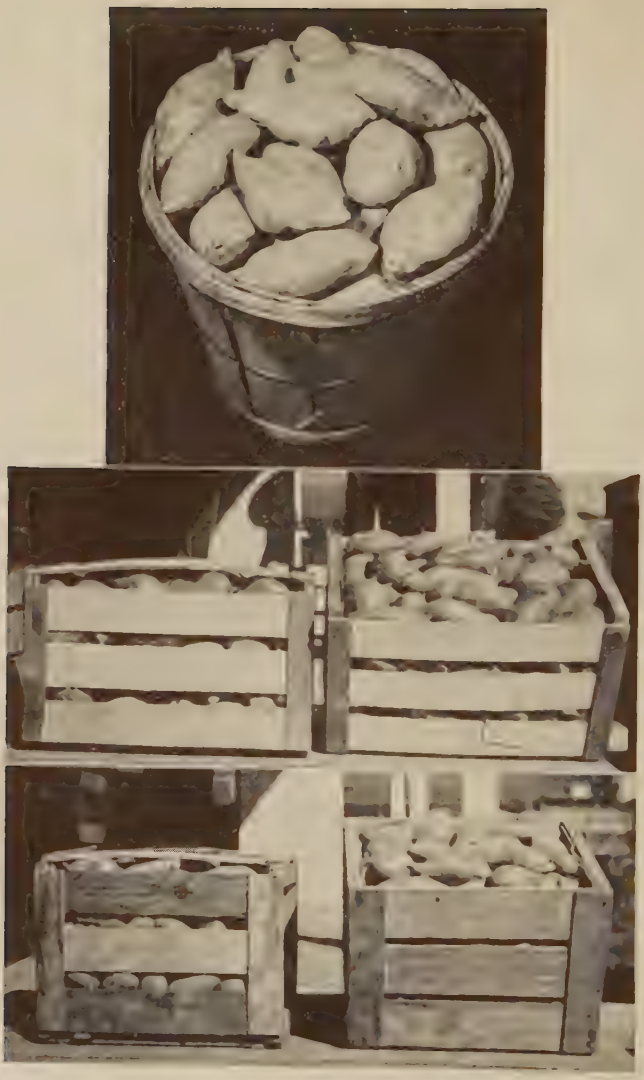

PLATE VIII.—WELL-GRADED AND WELL-PACKED SWEET POTATOES

Upper—Hamper of U. S. Grade 1. *Below*—Two Kinds of crates Showing Method of Packing. Courtesy of Bureau of Agricultural Economics, U. S. Department of Agriculture

scurfy potatoes do not command as high price as clean ones.

Potatoes badly infected with scurf undergo more loss by shrinkage in storage than do potatoes not affected with disease, hence, the loss is greater than is commonly believed. Poole reports loss of 40 to 44 per cent in weight of severely scurfed potatoes held in the laboratory at 18° to 25° C. for 45 days, as compared to losses of 15 to 21 per cent and 2.6 to 8 per cent for slightly scurfed potatoes and those free from scurf, respectively. Loss in the storage house corresponded closely to that found in the laboratory. Treating seed potatoes with corrosive sublimate solution will destroy the fungus. Scurf is worse on heavy soils and on soil containing a large quantity of organic matter. Poole experimented with various fungicides in New Jersey and found that sulfur, inoculated sulfur, and Bac-sul reduced the diseases to a minimum. He suggests, when the soil is badly infected, that 300 to 400 pounds of inoculated sulfur be broadcasted on the land about a month before the potatoes are to be planted. It should be borne in mind, however, that the sulfur increases acidity and this might be undesirable because of the effect on succeeding crops.

Root-rot—This disease is caused by the fungus *Ozonium omnivorum*, which is the same organism causing root-rot of alfalfa and cotton in Texas and other southwestern states. The organism enters the underground parts of the plant and spreads in both directions. On the potato it produces a firm brown rot which results in complete destruction. In the stem the organism produces a brown discoloration. It lives from one season to the next in the soil on dead plant material or on growing crops. Hard freezing kills the organism and this probably accounts for

the fact that it is restricted to the South. According to Harter it occurs in Texas, New Mexico, Oklahoma, and California. In some cases losses from this disease are very heavy.

Root-rot is most severe on poorly drained soils and during wet seasons. Since the organism grows on a great variety of plants it is very difficult to control. Harter suggests deep, clean cultivation, aeration of the soil, crop rotation, and careful selection of disease-free seed. It has not been known to injure corn or any of the other cereals, hence, these should be used in rotation.

Leaf-blight—This disease is caused by *Phyllosticta batatas* and appears on the upper side of the leaves as small roundish or angular spots, separated from the healthy tissue by a dark line. Inside this line is a strip of brownish tissue which has lost its greenish color and inside of that is a circular area, much lighter in color, in which a number of black bodies containing spores are found. This disease does not occur on any part of the plant except the leaf. It is seldom serious enough to require any control measures.

Leaf-spot—The fungus causing this disease is known as *Septoria bataticola* and is similar in general appearance to leaf-blight. The small spots, scattered indiscriminately over the foliage, are white in color, surrounded with a brown border. Black specks containing spores are found within the white area. This disease is not known to attack other plants. While it is widely distributed, it is not serious enough in any region to require control measures.

White-rust (Leaf Mold)—White-rust is caused by the fungus *Albugo ipomoeae-panduranae*. The first symptom of the disease is a loss of the green color in spots on the under side of the leaf. These spots become brown with a whitish, viscid growth,

which, finally, becomes more or less powdery. The powdery mass is made up of spores which start new infection if they fall on the leaf and conditions are favorable for their growth. The disease is widespread, but seldom serious enough to require remedial measures.

Soft-rot—This disease, caused by *Rhizopus nigricans*, is one of the most destructive in the storage house. The decay begins at one end of the root and develops rapidly, under favorable conditions requiring only a few days to cover the entire potato. Lauritzen and Harter [34] have shown that infection takes place almost exclusively through fresh wounds. The potatoes are first rendered soft and watery. After complete decay the root becomes firm, hard, and dry, and at this stage farmers frequently refer to the potatoes as being affected by dry-rot. If the skin is broken while the potato is still soft the organism forms a moldy growth on the surface and spores are produced. These spores spread infection to other potatoes. Since the organism is so widespread it is impracticable to attempt to eradicate it, but it can be controlled by careful methods of handling and storage.

It has been shown that temperature and humidity in the storage house have a marked effect on the growth of the soft-rot organism. At a temperature of 23° C. the optimum relative humidities for the infection of the roots by the organism range from 75 to 84 per cent. Infection decreases rapidly as the humidity is raised above or lowered below these optimum humidities. At relative humidities of 93 to 99 per cent very few infections occurred in halved roots in the experiments of Lauritzen and Harter. Since the resistance to infection is located in the surface layers of the wounded areas these investigators believed it is related to cork formation. Harter and Weimer [29]

found that cork formation occurs more readily at high than at low humidities.

Ring-rot—This disease is caused by the same organism as soft-rot. It differs from soft-rot in that decay begins at a point between the ends and forms a ring around the potato. Under conditions favorable to the mold, the potato may be destroyed totally. If, on the other hand, conditions are unfavorable to its growth it may develop no further than to form a ring around the potato.

Black-rot—This disease, which has been described as affecting the plants in the hotbed and in the field, also causes loss in storage. Harter [25] suggests that the loss caused by black-rot in the field and in storage probably equals that of all other diseases combined. At digging time black-rot spots may not show to any great extent since the point of infection is so small as to be invisible to the naked eye. Under conditions favorable to development of the disease, as high temperature and high humidity, the spots gradually enlarge and in a month or two they have formed conspicuous, round, sunken spots on the surface of the potato. Near the center of the spots numerous flask-shaped fruiting bodies are found. These produce the spores which are carried to other potatoes by insects or by workmen.

Dry-rot—This disease is caused by *Diaporthe batatatis*. It generally begins at the end of the potato, grows slowly, and produces a firm brown rot. The potato finally becomes dry, hard, and mummified. Small pimple-like protuberances, just visible to the naked eye, finally cover the surface. These produce myriads of colorless spores which serve to reproduce the fungus. The dry-rot fungus grows on the stems and vines above ground in the field and it is here probably that infection of the potatoes

takes place. If the skin of an infected root is scraped off, the tissue beneath presents a coal-black appearance.

Dry-rot is widely distributed but is not considered a serious storage trouble.

Java Black-rot—This disease, caused by *Diplodia tubericola*, is supposed to have been introduced into the United States on potatoes imported from Java. It is strictly a storage trouble and is quite widespread, but is more prevalent in the South than elsewhere. The disease usually begins at one end of the root, grows very slowly, and finally renders the potato, dry, hard, and brittle. The tissues beneath the skin become coal-black in color. The spores are produced in small receptacles beneath the skin and when the surface is broken they are set free.

Charcoal-rot—This rot is caused by *Sclerotium bataticola* and differs from others by the production of minute resting bodies throughout the potato, rarely on the surface. These bodies are coal-black and stand separated from each other. This rot causes some shrinking and drying of the potato, but the total loss to the crop is comparatively small.

Control of Storage-Rots

Since some of the serious losses due to storage-rots are caused by field diseases, it is very important to eliminate such diseases in the field. This is especially true of black-rot, stem-rot, and foot-rot. The storage of potatoes infected with black-rot is certain to result in serious loss, since the disease spreads rapidly throughout the bins or crates. Stem-rot itself does not produce much decay, but it opens the way for storage-rot organisms to enter the potato.

The care with which the potatoes are handled in the harvesting and storage operations and the management of the storage house have a marked effect on the development of storage-rots. Any cutting or bruising of the potatoes opens the way for storage-rot organisms to enter, hence, careful handling and the discarding of cut and bruised roots are important. The temperature and humidity of the storage house are also important and should be controlled so that loss by rots is reduced to the minimum. (See Chapter VII for discussion of harvesting and storing.)

Insects

The sweet potato is attacked by relatively few insects and, except for the sweet potato weevil, the injury done is usually not very great and control measures are seldom applied. Herrick [48] mentions the following insects as attacking the sweet potato: the sweet potato weevil, sweet potato flea beetle, striped sweet potato beetle, four species of tortoise beetles, sweet potato plume moth, sweet potato white fly, and sweet potato leaf folder. Berger [44] mentions Termites or "white ants" as burrowing into sweet potatoes and causing some damage in Florida. Only the sweet potato weevil is considered of sufficient importance to justify discussion here.

Sweet Potato Weevil (*Cylas formicaris Fab.*)—The adult is a slender ant-like snout beetle about one-fourth of an inch long. It is an introduced pest and is thought to be of Asiatic origin. While it was known in Louisiana as early as 1875 and in Florida in

1878, it was not given much consideration until within the past fifteen years. The weevil is now widely distributed in Florida, Louisiana, and Texas, and is found in one county in Georgia, in one in Oklahoma, in two in Alabama, and in five in Mississippi.

The sweet potato weevil is restricted for food to the sweet potato and closely related plants of the morning glory family. The goat's-foot morning glory (*Ipomoea pescaprae*), which grows in sandy places along tropical seashores, is considered a natural food plant. According to Chittenden [46] the beetle injures the sweet potato by feeding on the leaves, vines, stalks, and roots. The female lays eggs in the vines, in the stalks near the ground, and in the roots in the field, and also continues to breed in the roots in storage. The larvæ, on hatching, tunnel through the vines to the roots, the vines die, and the roots frequently become so badly riddled and filled with excreta, which imparts such a bitter taste that hogs will not eat them.

Losses of 25 to 50 per cent commonly are sustained and in severe infestations there may be total loss.

Where this insect is well established, infestation takes place through the over-wintered weevils. The weevils may winter over in stored sweet potatoes, and in roots left in the ground as volunteers, or through poor harvesting. An outbreak of the weevil in a new locality, remote from any other where it is established, in nearly all cases may be traced to the transportation of propagating material from weevil-infested localities.

Control measures for the weevil in regions where it is already established consist in cleaning up the sweet potato fields, storage houses, storage banks, and plant-beds, and in using plants known to be free from

the insect. As a result of two years' work Graf and Boyden [47] suggested the following rules for farmers:

1. The old fields should be thoroughly cleaned at harvest, the vines being fed to stock or burned, and the fields "hogged over."

2. The potatoes should be banked as far as possible from the old field and from the site selected for the field the next year.

3. All potatoes on the farm should be disposed of early.

4. No potatoes or plants from the old crop should be used on the farm and no draw-bed should be planted.

5. Old potato banks should be cleaned as soon as empty.

6. Only draws from sources known to be free from the weevil should be used.

All regions known to be infested with the sweet potato weevil should be strictly quarantined to prevent the movement into uninfested territory of any material likely to carry the insect. Most of the Southern States, if not all of them, have laws prohibiting the shipment of sweet potatoes, sweet potato plants, and any morning glory plants or parts of plants from infested to uninfested areas. Such laws, strictly enforced, delay, if they do not prevent, the spread of the weevil. Growers and handlers of sweet potatoes should comply cheerfully with all laws and rules adopted by the various states for these were made for the protection of the sweet potato industry. Growers and handlers should keep informed at all times on the status of weevil distribution and injury in their localities. Such information can be secured from the agricultural colleges and experiment stations.

VII

HARVESTING AND STORING

The time and method of harvesting and the care used in handling the sweet potato crop from the time it is dug until it finally is disposed of, determine to a large extent the length of time it can be kept and the quality of the product when it reaches the consumer. It is important to use the utmost care in all handling operations, for the sweet potato is injured easily and injury is certain to result in some loss, and in many cases in total loss of those actually bruised or cut. Sweet potatoes should be handled as carefully as apples or oranges.

Time of Harvesting

Sweet potatoes grown for the early market are harvested when they reach marketable size regardless of the stage of maturity. The main crop should be allowed to reach maturity, if practicable, because immature sweet potatoes do not keep well in storage. The stage of maturity can be determined by cutting a few potatoes and leaving them exposed to the air for half an hour. If the cut surface dries it is mature, but if the sap continues to flow and remains sticky the potatoes are not mature. It is advisable to dig the potatoes

on a bright day when the soil is dry as wet soil sticks to them and delays drying.

Where the growing season is short, harvest is delayed until there is danger of freezing, so that the potatoes are seldom dug in the northern part of the sweet potato-growing region until the vines have been touched by frost. They should be dug before killing frosts are expected since chilling the potatoes injures them. If the vines are killed to the ground, the potatoes should be dug immediately, or the vines cut off and a furrow thrown over the row. This will protect the potatoes until they can be dug, but digging should not be delayed longer than necessary.

Methods of Harvesting

Since sweet potatoes are easily injured they should be dug and handled in such a way that injury is kept at a minimum. Cuts and bruises injure the appearance of the potatoes, increase skrinkage and loss due to rots, and shorten the keeping period. Results of experiments reported by Thompson and Beattie [74] illustrate this point. In 1917 and 1918 potatoes cut or bruised in harvesting were sorted out and kept separate to determine the effects of cutting and bruising on shrinkage and decay in storage. These were handled carefully and stored in crates in comparison with uninjured potatoes of the same varieties kept under like conditions. Three varieties, Big-Stem Jersey, Nancy Hall, and Southern Queen, were used. The average shrinkage of the injured potatoes was 28.13 per cent, and of the uninjured

lots 13.83 per cent; while the loss due to decay was 13.79 and 0.75 per cent, respectively, for the storage period of 164 days. The Southern Queen had the lowest shrinkage, 21.88 per cent, and also the least decay, 2.69 per cent, for the injured potatoes, and the Big-Stem Jersey showed the greatest loss in both shrinkage and decay—33.83 and 27.52 per cent, respectively. The losses for Nancy Hall were 29.51 by shrinkage and 9.29 per cent by decay. It is a matter of common observation that the Southern Queen stands rough handling better and keeps longer than most other standard varieties. It should not be inferred, however, that careful handling is not important for this variety for, under ordinary storage conditions, the loss would have been much higher. The conditions under which these potatoes were kept were almost ideal. Therefore, the loss was kept down to the minimum. The loss due to decay and to excessive shrinkage does not represent the total loss in value of the product. Cut and bruised potatoes are unattractive in appearance and the injured parts must be cut away when preparing them for the table.

Where the crop is grown on a small scale for home use the potatoes may be dug with a fork or with a claw hoe, but care should be exercised to prevent cutting them. A large part of the crop is dug with a plow or some similar implement. One of the best types of diggers is a plow with rolling colters on the beam to cut the vines and with rods attached to the moldboard to free the roots from the soil. The moldboard of this

type of plow is short and throws little soil, and the fingers attached lift most of the potatoes to the surface. The point of the plow should run beneath the potatoes and to one side of the row to prevent splitting the hill. It is important to set the colters far enough apart to miss the potatoes. A "middle buster" is also a good implement to use for digging. This runs beneath the row and lifts the potatoes.

After the potatoes are dug they are usually scratched out by hand and left on the surface of the soil long enough to dry. This requires only an hour or two on a bright day. The potatoes should never be thrown from one row to another, thrown loose into the wagon bed, or put into bags, since any one of these methods of handling cause bruising of the roots. Some grading should be done in the field, in order to reduce handling to the minimum. A good method is to go over the rows and pick up the sound marketable potatoes in one basket or crate, gather all the seed stock in another, and put the injured ones in a third container. These baskets or crates should be loaded on a wagon with springs and hauled direct to the storage house. If the potatoes are to be stored in baskets or crates the different grades should be stored separately, and when stored in bulk they should be placed in separate bins. By following this method it will not be necessary to grade at the storage house; this will effect a saving of time and reduce the loss by decay, since the extra handling causes some bruising.

When the potatoes are marketed as soon as

harvested they may be graded and packed in the field by the method described, or this work may be done in a packing shed or house.

Essentials of Good Storage

To keep sweet potatoes in good condition they must be (1) well-matured before digging, (2) carefully handled to prevent cutting and bruising, (3) well cured immediately after being put in storage, and (4) kept at a uniform temperature between 45° and 55° F. after they are cured. The first two essentials have been discussed. The third and fourth also may be secured in a storage house where artificial heat can be supplied. The house must be so constructed that it can be ventilated when necessary, and yet be made nearly air-tight in cold weather. It is economy, in the long run, to build a substantial storage house because it will last longer and require less attention than a cheap, poorly-constructed one. The chances of loss also are greater in a poorly-constructed house than in a well-built one.

Construction of Storage Houses

Sweet potato storage houses may be built of wood, brick, cement or stone. Wooden houses are the most common and generally are preferable because they are cheaper and easier to keep dry than the other types. It is difficult to keep moisture from collecting on the walls of a cement, brick or stone house and, where such houses are built, they should be lined with lumber, so as to keep the air in the house from coming in contact

with the masonry walls. In humid regions it is best to built storage houses on foundations that allow a circulation of air under them. The "dug-out" or house built wholly or partly underground is not satisfactory for storing sweet potatoes, especially in the South, because it it practically impossible to keep such a house dry and moisture in the storage house nearly always increases the loss due to storage rot.

The foundations for the storage house may be in the form of pillars, or of solid walls, and should be of such a height that the floor will be about on a level with the bottom of a wagon bed. Where solid walls are built, these should be provided with openings for ventilation under the house. Small windows, placed every 10 to 12 feet, are satisfactory. These openings should be screened to keep out mice and rats.

The walls, floor, ceiling, and roof should be well insulated so that changes in the outside temperature will not be readily felt on the inside of the house. In most regions the walls should have two layers of boards on the outside of the studs and two on the inside with heavy building paper between the layers. In the colder regions greater insulation is needed. It is not desirable to fill the walls with sawdust or other similar absorbing material as they take up moisture from the air and keep the walls wet. The floor and ceiling should be double, with building paper between the layers, and in cold regions even more protection must be given. Figure III shows the details of construction of walls of sweet potato storage

houses as described by Thompson [73] for use in the South.

Thorough ventilation is essential and this can be provided by means of windows, doors, and ventilators in the floor and through the roof. The doors and windows should be made so as to close

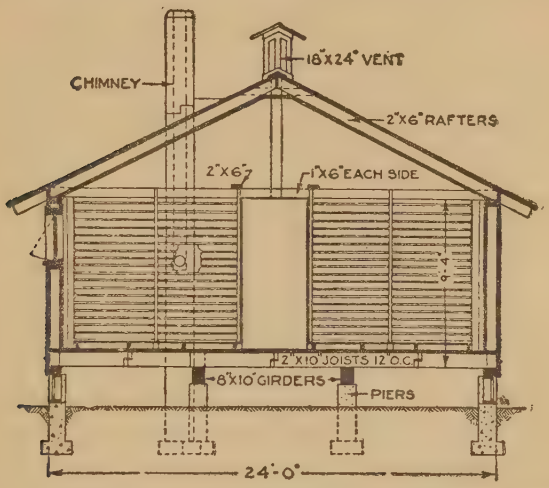

FIG. I.—CROSS SECTION OF A SWEET POTATO STORAGE HOUSE Size 24 by 59½ feet, having a capacity of 4,000 bushels in crates or 5,200 bushels in bulk, showing the arrangement of bins and other structural details. Courtesy Bureau of Plant Industry, U. S. Department of Agriculture

tightly. It is desirable to make two sets of doors for each door opening, one to open outward and the other to open inward, and both sets should be well padded. Windows also should be doubled and well padded. It is advantageous to use glass-sash windows to admit light when working in the

house and to cover these with heavy shutters which open from the outside. The windows and doors, as well as the special ventilators, should be so made that they can be opened and closed easily and quickly as desired. Ventilation from below may be made by cutting out sections of the floor in the corners and around the stoves in case this method of heating is employed. The openings around the stove prevent overheating of the

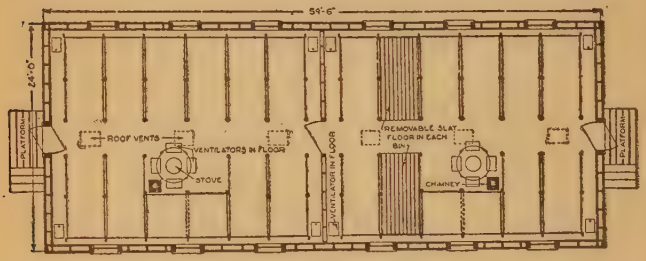

FIG. II.—FLOOR PLAN OF A SWEET POTATO STORAGE HOUSE
Size 24 by 59½ feet, having capacity of 4,000 bushels in crates or 5,200 bushels in bulk. Courtesy Bureau of Plant Industry, U. S. Department of Agriculture

potatoes near the stove. A small house, 12 x 16 feet, can be suitably ventilated by the use of two 10 x 12-inch floor ventilators near the stove and one 12 x 18-inch ventilator in each corner, and by three 12 x 12-inch ventilators through the roof. The ventilators in the roof should extend through the ceiling and each one should have a trap at the lower end for closing when desired. These ventilators may be of a box type, and each one should be provided with a roof over it to keep out rain. All floor openings should be screened to keep out mice and rats.

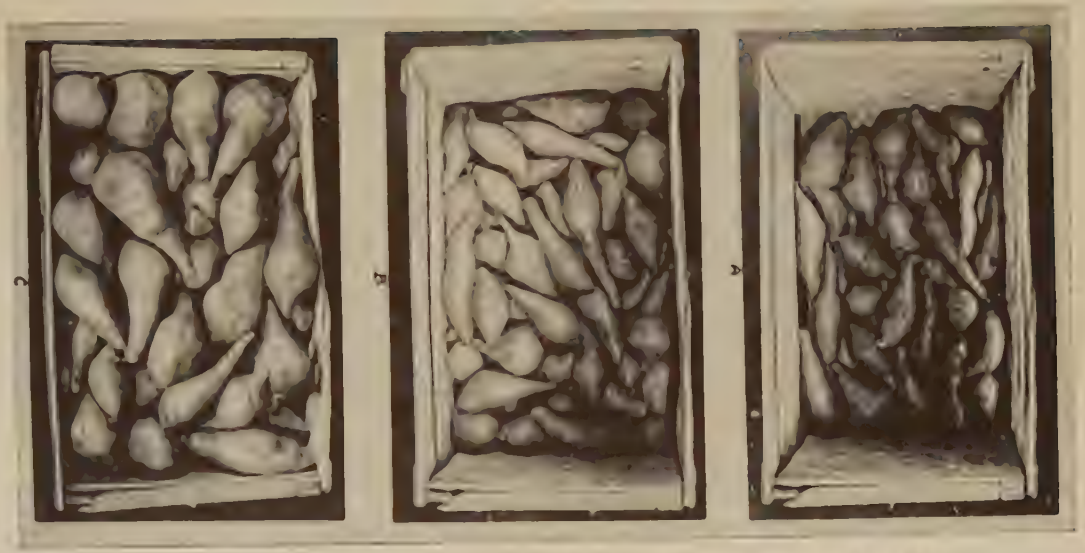

PLATE IX.—CRATES OF SWEET POTATOES SHOWING PROPER GRADING AND PACKING

A—The First Layer Placed With Longest Diameter of the Potatoes Parallel to the Sides of the Crate.

B—Partially Filled Crate.

C—Filled Crate. Courtesy of Bureau of Agricultural Economics, U. S. Department of Agriculture

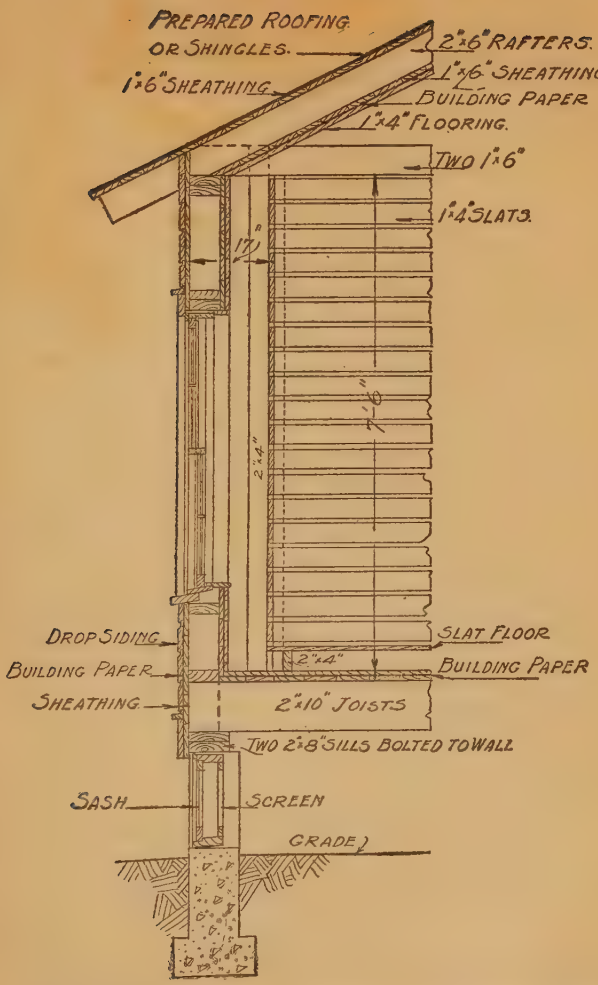

FIG. III.—CONSTRUCTION OF A SWEET POTATO STORAGE HOUSE. Details of the foundation, floor, wall, and roof. Courtesy Bureau of Plant Industry, U. S. Department of Agriculture

The arrangement of the interior of the storage house depends upon the method of storage used. Where the potatoes are stored in baskets or crates no interior construction is necessary, although it is desirable to set the packages on false, slat floors for purpose of ventilation. If bins are used, the interior of the house should be arranged for convenience in handling the potatoes and in caring for the house. There should be a passageway 3½ to 4 feet wide between the rows of bins and sufficient space should be left to allow access to the ventilators in the corners of the rooms. The size of the bins will depend somewhat on the arrangement and size of the house, but it is not advisable to make them more than 5 feet wide, 6 to 8 feet deep, and 10 to 12 feet long. There should be a 6 to 12-inch space between the walls and the bins to permit air to circulate. (For details of bin construction see Farmers' Bulletin 1442.)

Reconstructing Buildings for Sweet Potato Storage

On many farms, especially in the South, there are abandoned tenant houses, warehouses, tobacco barns, and other structures which may be reconstructed and used for storing sweet potatoes. Such structures should be used rather than building new houses for sweet potato storage. The same methods of insulating, heating, and ventilating may be employed as are recommended for new sweet potato storage houses.

Special attention has been given to the use of

tobacco barns for storing sweet potatoes, since in some sections these structures can be used for both tobacco and sweet potatoes. The tobacco is cured before the season for harvesting sweet potatoes and by a relatively small expense the tobacco barn can be remodeled for the dual purpose. The changes do not impair the building for its primary purpose. (For detailed directions for remodeling flue-heated tobacco barns the reader is referred to Farmers' Bulletin 1267.)

Management of the Storage House

Success in keeping sweet potatoes depends, to a considerable extent, on the care used in managing the house. Careful attention must be given to temperature and humidity and these are controlled by use of artificial heat and by ventilation.

Before the potatoes are brought in, all parts of the interior of the storage house should be cleaned and disinfected. Disinfection may be accomplished by spraying with copper sulfate solution made by dissolving 1 pound of copper sulfate in 25 gallons of water, or with a solution of formaldehyde made by mixing 1 pint of formalin (40 per cent) in 30 gallons of water. All parts of the interior of the house must be sprayed thoroughly. The baskets or crates used in handling the potatoes also should be disinfected if they have been used before.

Handling the Potatoes—If baskets or crates are used as storage containers, they should be filled carefully in the field and hauled direct to the storage house. They should be placed on a

false floor in tiers with sufficient space between the layers and tiers to allow circulation of air in all directions. The filled containers should be handled carefully to prevent unnecessary bruising of the potatoes.

When bins are used the potatoes should be hauled to the storage house in padded baskets or crates. In filling the bins, the workmen should begin at the rear and pour a layer of sweet potatoes about 2 feet deep in all of the bins rather than fill one bin at a time. If the bins are 8 or 10 feet long, it is a good plan to divide them into two parts by the use of partition boards between cleats nailed to the middle support. By dividing the bin in this way the potatoes in the front part can be removed without disturbing those in the other half of the bin. This is important where they are sold in small quantities.

It has been believed generally that when sweet potatoes begin to decay they should be sorted to pick out those showing any rot. Experimental results reported by Thompson and Beattie [74] and observations lead the writer to believe that this is not a desirable practice. In seven tests the results were in favor of not sorting, even though the potatoes were handled carefully to avoid bruising. Sorting is certain to result in some bruising and it also distributes the disease to other potatoes. One decayed potato left undisturbed might be in contact with 4 or 5 sound ones, all of which would eventually decay. When sorted, each of these potatoes which had become infected might be placed in contact with several unin-

fected ones thereby spreading the disease to them. Since sorting increases rot and in addition requires labor, it seems inadvisable to disturb sweet potatoes until they are to be placed on the market. If decay appears to be serious, the potatoes should be disposed of immediately.

Crates or Baskets vs. Bins—Experimental results and the practice of growers lead to the conclusion that crates or baskets are preferable to bins. Potatoes are handled more when bins are used than where crates or baskets are employed and this generally results in greater loss due to storage-rots. The small receptacles have an added advantage in that by their use as many potatoes can be taken out for market as are desired without disturbing the remainder. Where sweet potatoes are marketed in baskets or hampers, these containers can be used for storage, thus insuring clean receptacles without any added expense. Before marketing, the potatoes should be sorted and repacked in order to pick out any decayed or off-type roots and to fill the containers.

Curing Sweet Potatoes—Before the potatoes are brought in a fire should be started in the storage house to dry it out and to raise the temperature to 80° or 90° F. This temperature, with thorough ventilation, should be maintained until the potatoes are cured. The length of time required depends on the weather conditions and, to some extent, on the variety of potatoes. Thorough ventilation is necessary even if it is not possible to keep the temperature up to 80° F.

since the moisture-laden air must be allowed to escape. During bright warm days the doors and windows, as well as the ventilators, should be left open, while curing is going on, but on cloudy or rainy days and at night the doors and windows should be closed. Some of the ventilators should be left open even on rainy days during curing. The air inside the house should be kept warmer than the outside air as this will prevent moisture from being deposited on the walls and other parts of the interior. As the air warms it expands and takes up moisture and, being lighter than the cooler air entering, it passes out through the roof ventilators. When the potatoes are cured, the temperature should be lowered gradually to 50° or 55° F. and maintained as near that temperature as possible for the remainder of the storage period.

For the beginner there may be some difficulty in determining when the potatoes are cured, but with a little experience this difficulty will disappear. The experienced person determines this by the "feel" of the potato, which cannot be described satisfactorily. The safest way for the beginner is to allow curing to continue until sprouts begin to appear on the potatoes in the warmer portions of the house, which is usually in the top layer. When these sprouts begin to show the temperature should be reduced at once.

Heating the Storage House—The type of heating apparatus used depends to a considerable extent on the size of the house. For a small house a sheet-iron wood stove, or a small coal

stove, may be used. In many sections of the South small sheet-iron stoves are used which are satisfactory if watched carefully. These have the advantage over coal stoves in that they heat up quickly and often all that is necessary is to raise the temperature a few degrees and then to let the fire go out. Coal stoves are more satisfactory where artificial heat is required during most of the storage period. In large, commercial houses hot-water, steam or hot-air heating plants generally are used, especially in the North. When stoves are used, their location in the house depends on the size of the house and the direction of the prevailing winds. Ordinarily where one stove is used it is placed near the center of the house. However, if the cold wind strikes one end the stove should be placed in that end. The larger houses have a stove in each end but, in case they are divided into rooms, it is necessary to place a stove in each room. In large houses it is desirable to make several rooms and in this case each room should be heated separately or have independent heat-control. Temperature and moisture can be controlled by ventilation and by use of artificial heat. In most sections of the South it is not necessary to keep heat in the storage house much of the time. It is only necessary to build a fire when the temperature goes to 45° F., or below, or during wet weather when moisture is likely to deposit on the walls and other interior parts of the house. When the temperature goes too low during the night it often can be raised by opening the house during

the warmer portion of the day. When the temperature goes above 60° F., it should be lowered by opening the house during the cooler part of the day, but this should be done only if the atmosphere is fairly dry for, if humid, the lowering of the temperature will cause deposition of moisture. By giving close attention to opening and closing the house, very little artificial heat will be needed in the lower South after the potatoes are cured. In the northern part of the sweet potato-growing region artificial heat is needed during most of the storage period.

Storing Sweet Potatoes in Banks and "Cellars"

Storing in banks, or other types of outdoor storage, is sometimes necessary, but it should be remembered that the temperature and moisture cannot be controlled in them and that potatoes so stored are not as good as those kept in suitable houses. The main disadvantages of bank or pit storage are: (1) the large loss due to decay, (2) the inferior quality of the sound potatoes due to lack of curing, (3) the loss on the market, because banked potatoes will not keep as long after being removed as those from storage houses, and (4) the inconvenience of getting the potatoes when needed, especially during cold or rainy weather. It is estimated by reliable authorities that the loss by decay of sweet potatoes stored in banks averages at least 30 per cent. In some seasons it is very low, while in others it runs from 50 to 100 per cent. Experiments in

the South reported by Thompson and Beattie [74] show losses in 10 tests ranging from 4 to 40 per cent, averaging 14.33 per cent, while comparable lots kept in storage houses showed losses from one-half to 2 per cent, averaging 1.20 per cent. These sweet potatoes were carefully handled and the banks were well-made, much better made in fact than the average.

Sweet potatoes are not stored in banks in the North and to only a limited extent in the colder portions of the South. In the milder portions of the South it is better to store sweet potatoes in banks, or outdoor cellars, than not to store them at all. By using the best methods of banking, the loss by decay can be reduced but not eliminated, because it is impossible to control temperature and moisture. The following description of methods of making banks and storage cellars is taken from Farmers' Bulletin 1442. "Storage pits should be located where the drainage is good. In making a pit a little of the surface soil is thrown back to form a level bed of the size desired. It is a good plan to dig two small trenches across the bed at right angles to each other to provide for ventilation at the bottom. Lay boards or place troughs over the trenches, and at the point where the trenches cross set a small box on end to form a flue up through the pile of potatoes, as shown in Plate VI. The earth floor of the pit is covered with 4 or 5 inches of straw, hay, leaves, or pine needles, and the potatoes are placed in a conical pile around the flue. A covering of straw, hay or

similar material is put on the pile and over this a layer of soil. The covering of soil should be only a few inches thick at first, but increased as the weather gets cold. Keep the ends of the trenches and flue open until it is necessary to close them to keep out the frost. It is better to make several small pits rather than one large one, because it is best to remove the entire contents when the pit is opened."

A type of storage "cellar" made entirely above ground is often used in the South for storing sweet potatoes. This form of storage is much better than pits or banks. The potatoes can be cured in the outdoor cellar, and it is easier to get them out when wanted for the table or for market. A good type of outdoor cellar can be made as follows: Set a line of posts for the center supports and on these posts put a ridgepole. Against the ridgepole place one end of planks, poles, or slabs, with their opposite ends resting on the ground on either side. The ends of the inclosure are boarded up, a door being provided in one end. The structure is covered with sod to a thickness of 5 or 6 inches. It is a good plan to put a ventilator through the top and to leave two or three openings in the sides near the ground. Provision should be made to close all these openings during cold or wet weather. By placing a small stove in the storage cellar the potatoes can be cured in the way that has been described for the storage house. The potatoes are usually piled on a layer of straw, leaves, or pine needles placed on the ground. A better method is to build a

slat floor a few inches from the ground and pile the potatoes on the floor. This floor will allow the circulation of air under the potatoes, which will aid in curing them.

Home Storage

Where only a few bushels of sweet potatoes are to be stored for home use they may be kept in any dry, fairly warm part of the dwelling. The writer has been successful in keeping them near the furnace in the basement. As soon as the potatoes are dug they are put in crates or baskets and placed near the furnace. After the potatoes are cured they are moved away from the furnace to a cooler location. A basement is satisfactory if it is dry and fairly warm and such conditions often prevail in the furnace room. Where a coal or wood stove is used in the kitchen a small quantity of potatoes can be cured on shelves placed near the top of the room. After the curing, they may be kept in any dry room where the temperature remains fairly constant, between 45° and 60° F.

Changes in Sweet Potatoes During Storage

During the curing and storage periods, sweet potatoes are constantly undergoing changes and the rate of these changes depends on the conditions in the storage house. One of the most noticeable changes is the loss in weight, due largely to loss of moisture, but also to losses of other substances in respiration. The loss in weight ranges from 5 to 25 or 30 per cent depend-

ing on temperature and humidity in the storage house, and on the variety and methods of handling. Under good storage conditions this loss in weight should not exceed 15 per cent for a storage period of 5 months, and half of the loss should take place during the curing period. Generally, the shrinkage is slightly higher in crates than in bins. Results of studies made by Thompson and Beattie [74] on three varieties, Big-Stem Jersey, Nancy Hall, and Southern Queen, showed an average skrinkage of 14.02 per cent for potatoes stored in crates and 12.82 for those stored in bins under the same conditions. This loss in weight was for the entire storage period of over 5 months and is the average of 2-years' results. Slightly over half of this loss occurred during the curing period of about 2 weeks. The decay was more in bins than in crates, but was very low in both. Manns [69] has shown that this loss of moisture is necessary to keep down losses due to rot in storage. The shrinkage should be at least 5 per cent by weight during the curing period.

In general the higher the temperature the greater the shrinkage. In the studies reported by Thompson and Beattie three varieties averaged 13.83 per cent loss in weight in 164 days when the temperature was maintained between 50° and 55° F.; 15.27 per cent with temperature between 55° and 60° F., and 15.70 when the temperature was maintained at 60° to 65° F. These percentages are averages of 3 years' results. The temperature during the curing period was the same in the three rooms.

Chemical Changes—It has been assumed by some experimenters that the decrease in weight during storage is due to loss of moisture, but this does not account for all of it. The percentage of water in sweet potatoes does not vary to any great extent during storage, although it is well-known that moisture is lost. The percentage of water found in the potatoes at various times during storage does not tell the story, because the loss of moisture is masked by the loss in solids, mainly sugars, in respiration, and by the water formed in the same process.

Harrington,[62] Shiver, [72] Keitt,[66, 67] and Hasselbring and Hawkins [63, 64] have shown that during curing and storage there is a loss of starch and a corresponding increase in sugars. This change goes on rapidly at first, but gradually decreases until it reaches a minimum late in the storage period. The data presented by Hasselbring and Hawkins [64] indicate that late in the season, March to June, in the vicinity of Washington, D. C., there is a re-formation of starch accompanied by a disappearance of cane sugar.

The change at the beginning of the storage period seems to be due to internal causes and is largely independent of external conditions. In the studies reported by Hasselbring and Hawkins the transformation took place at temperatures as low as 4° C. and as high as 30° C. At the lower temperature there is a rapid disappearance of starch and an accompanying increase of cane sugar, but the potatoes rot before equilibrium is reached.

Results of recent studies by Culpepper and Magoon [59] show that not only do marked changes take place in sweet potatoes during curing and storage, but that further alterations occur during the cooking process. The physical evidences of the changes, as manifested in the cooked product, are a marked softening of the flesh of the potato and a very considerable increase in sweetness. "The chemical changes taking place are evidenced by a transformation of part of the starch to dextrin and sucrose, thus altering the starch-moisture ratio, and during cooking, a splitting of a portion of the starch to maltose. These changes are responsible for the altered physical consistency of the canned product and its increase in sweetness. The ratio of starch to moisture determines the consistency, and the chief factor causing the difference in sweetness is the amount of sucrose formed."

VIII

MARKETING

PROFITS in growing sweet potatoes depend as much on the method of handling and marketing as on good cultural practice. It should be borne in mind, however, that successful marketing begins with the selection of the variety and the seed stock for planting, and that the care used in growing and handling the product determines to a considerable extent its salability. The essentials for success in marketing sweet potatoes are: (1) A good product of the kind desired on the market; (2) careful handling; (3) careful and uniform grading; (4) good packing in containers suitable to the product; (5) judicious selection of markets, which necessitates careful study of market demand, and (6) good salesmanship. A good salesman gives attention to all of the essentials mentioned.

The first essential mentioned, a good product of the kind desired, has been discussed in the chapter on varieties, but it should be emphasized that for successful and profitable marketing we must have a product the consumer wants. The second essential has been discussed in the chapter on harvesting and handling.

Grading

Well-graded sweet potatoes of inferior quality frequently sell to better advantage than poorly graded or ungraded stock of good quality. In separating sweet potatoes into grades all characters that affect the marketability of the product should be considered. These include size, shape, and color of the product, and freedom from injuries due to diseases, insects, or other causes. It should be borne in mind that a few inferior or injured specimens in a container determine to a considerable extent the price paid for the entire contents. Therefore, such specimens should be discarded. Very often the good potatoes in an ungraded lot will bring a higher price than the entire lot. Grading such a lot of potatoes and keeping the low-grade product at home would reduce the cost of transportation and marketing, favorably affect supply and demand, and furnish feed for livestock on the farm.

Not only should sweet potatoes be carefully graded, but there should be some standard that applies to a region, or preferably to the entire country. Uniformity in grading is essential where sweet potatoes are sold on grade. Standard grades are important in marketing at a distance and are essential for good market information and inspection. Lack of grade standards makes market quotations unsatisfactory to the grower because it is impossible to describe the product in terms that are understood. With the use of standard grades for sweet potatoes the

seller and buyer have a common language in the grade name or number. This eliminates a great deal of friction between producer and dealer due to lack of understanding and also reduces loss caused by rejections, delays, and dishonest dealing. Standardizing grades is one of the first steps in the improvement of marketing taken by any successful marketing organization. Grades provide a basis for sale, and their use facilitates the making of contracts for future delivery, sales by wire, inspection of the product at shipping points and receiving markets, cooperative pooling, financing through warehouse receipts, and the intelligent comparison of prices.

When sweet potatoes are sold at harvest time, only one grading is necessary, but if the crop is stored the potatoes should be graded again for market, no matter how well they have been graded at harvest time. The first grading may be done either in the field or at the storage house. Grading at the storage house is commonly done on portable tables which consist of frames of suitable height with burlap fastened over the tops. As the potatoes are delivered the contents of the containers are emptied on the burlap-topped tables. The graders sort out and pack the potatoes that conform to the grade requirements; the balance are kept at home. If the potatoes have been well graded at harvest time and little or no decay has developed in storage, the regrading may be done by partially emptying the container and picking out damaged or diseased specimens. Better packing can be done, however, by remov-

ing all of the potatoes and repacking. The graders and packers should wear cotton gloves and should be careful to prevent bruising.

Tentative grades for sweet potatoes, promulgated by the United States Department of Agriculture, are being used generally by shippers. These grades were developed for all sections and they necessarily permit considerable variation. It is possible, therefore, to comply with these grades and have a product which lacks uniformity in size and shape. Shippers should not be satisfied with meeting the minimum requirements of these grades. As a rule only U. S. No. 1 stock should be shipped to distant markets and this stock should be selected for uniformity in size, shape, and color.

Specifications for U. S. grades are frequently revised and for this reason are not given here. It is suggested that growers and handlers write to the United States Department of Agriculture, Washington, D. C., for grade specifications.

Packing

Sweet potatoes should be packed in clean, neat, substantial containers which show off the product to good advantage when opened for inspection by the buyer. A slack pack is generally characteristic of southern-grown sweet potatoes. Unless the container is more than level full when packed, the constant jarring and jolting of a long freight haul cause it to reach its destination only partially full. Loose packing allows the potatoes to shift about in the container and this results

in bruising which is often followed by decay. The irregular shape of the sweet potato does not lend itself to a jumble pack. To carry properly and to arrive full at destination each potato should be placed in the proper position in the package. Each layer should be so placed that the vacant spaces are filled. In packing in barrels, small lots may be poured carefully from containers and the barrel rocked back and forth to cause settling. With any type of container it is desirable to face the top layer but this layer should be representative of the contents of the package.

Crates, hampers, boxes, baskets, barrels, and even bags are used as market packages for sweet potatoes. According to Gatlin [60] the barrel is the most popular package in the East, with bushel hampers a close second, the bushel crate third and the bushel basket fourth. In the central group of states—Kentucky, Ohio, Illinois, Wisconsin, and Michigan—the hamper is by far the most common, the barrel next and the bushel basket third. In the West the demand is about equal for hampers and bushel baskets. In the South bags are still in use for shipping to local markets, but the tendency is toward a better container. The bag is a very inferior container as it does not protect the potatoes against injury and does not show off the product to good advantage.

An amendment to the Federal food and drugs act provides that goods in package form shall be deemed misbranded unless the quantity of the contents is plainly and conspicuously marked on

the outside of the package in terms of weight, measure, or numerical count. This means that sweet potatoes, shipped in interstate or foreign commerce, or offered for sale in the District of Columbia or territories of the United States, are subject to this act if they are put up in package form. It is desirable also to indicate the quality of the product, as U. S. Grade 1, if the potatoes have been graded according to the recommended United States grades.

Selling

Many farmers are successful as growers, but "fall down" on the selling end because they have not given as much study to merchandising as they have to production. To be successful in marketing sweet potatoes, as with other farm products, the farmer must study the methods used by the produce trade. He must study markets. and market demands.

In local marketing the grower may sell to the consumer by house to house calls or on public markets, but the former method is going out of use because it is uneconomical in time. Even on public markets most growers sell mainly to buyers for retail stores or to hucksters. Wholesale selling on local markets may be direct to retail grocery stores, to retail fruit and vegetable dealers, to wholesale produce dealers, or the product may be sold on commission by commission dealers. The best method of selling depends largely on the desire and the ability of the grower. Some growers are more successful when they do

their own selling, while others do better when they devote their attention to the producing end and let dealers sell the product for them.

In selling to distant markets there are several methods which may be used. The potatoes may be sold to track-side buyers representing large dealers, to local shippers, consigned to commission dealers and sold on commission, sold by wire to large dealers, or handled through a cooperative selling organization. The cooperative organization may employ any or all of these methods of selling. No particular method of selling can be said to be the best. Under some conditions one method is preferable, while under others another method could be used to better advantage. In general, selling at a loading station is most satisfactory to the grower, where there is enough business to attract buyers. Selling on commission is not favored generally by growers because they must stand all the risk until the goods are sold. In addition to this, farmers are somewhat suspicious of commission dealing and dealers. However, it should be remembered that there are many honest and reliable commission men, and that most of them give the shipper what is due him. The grower who ships his own products should take the trouble to find the honest, reliable commission men rather than consign his shipments to any one who happens to solicit his business.

Cooperative marketing has been successful where the growers have felt a real need for it and where they have loyally supported their own

organization. It is, however, no cure-all for the marketing ills and should not be undertaken until sentiment is overwhelmingly in favor of it. When there is such an attitude, cooperative marketing can accomplish good results through pooling of the products and resources, standardizing grades, grading and packing, and through the ability of an organization to secure competent and able management.

Market Reports

Any one who attempts to sell his own products should keep in touch with the markets through all the means available. These should include the market reports in local papers, and reports published by the state and federal marketing organizations. For large shippers the daily and weekly reports of the Bureau of Agriculture Economics of the U. S. Department of Agriculture and of some of the state marketing organizations are especially valuable. These reports give information on the quantity on the market and in transit as well as the price and the status of the market.

The Bureau of Agricultural Economics also issues reports on the commercial supply of sweet potatoes held in storage. These reports show the quantity stored at harvest time, the movement out of storage, and the quantity remaining at the time each report is made. The information in these reports enables the shipper to determine when to sell. It also tends toward a more even distribution throughout the year and toward stabilization of prices.

IX

SELECTED REFERENCES

This list of references is intended to include the publications that are likely to prove most useful to persons who wish to secure additional information about sweet potato growing and handling. There are many other publications on sweet potatoes which may be of interest to the student.

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